MACHINERY.

Vol. 6. January, 1900. No. 5.

AMONG THE SHOPS.

SOME INTERESTING NOTES TAKEN IN THE SHOPS OF THE ARTHUR COMPANY, NEW YORK

Among the numerous general machine shops of New York City that of the Arthur Company, on Front street, is well worthy of notice on account of the many unique specimens of model work to be seen there, besides shop tools and appliances of more than ordinary interest. The business was started in a modest way something over twenty years ago by James Arthur, the president of the present company, which is a close corporation consisting of the father, two sons and one daughter.

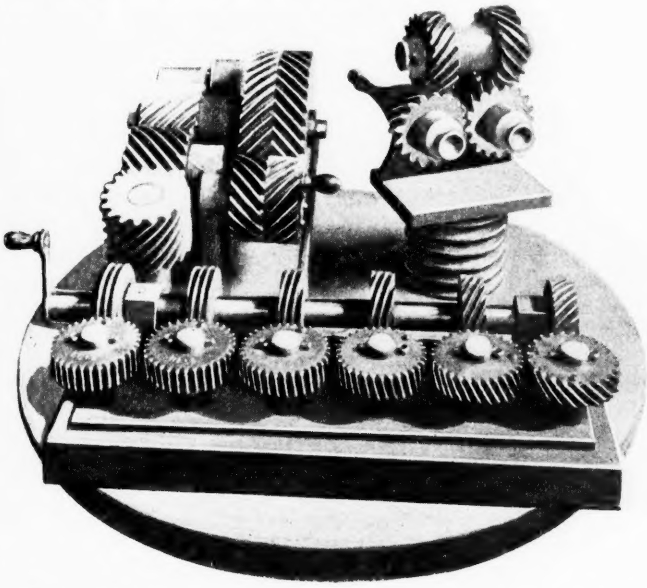

Fig. 1. Models made for technical schools to illustrate the peculiarities of helical gearing. The model in the foreground shows the gradation from a worm to a helical gear.

The business of the company was originally general repair work, but they are now quite extensively engaged in manufacturing valves for all sorts of service, flanges, hoists, propeller wheels, cut gears, etc. The latter line of manufacture has been taken up only recently, but some as interesting specimens of gear cutting are exhibited as the writer ever saw. Some of this work is shown in the clock illustration in Fig. 3. The teeth in all the gears are cut and the train includes specimens of helical and bevel gears, besides the ordinary spur gearing, which, of course, constitutes the greater part of the mechanism.

An Interesting Clock.

Although the readers of MACHINERY may not be particularly interested in horology, we think they will be interested in some of the details of this clock on account of its design and the mechanical accuracy of the workmanship. Clocks with cut gears are not rare, neither are those which keep accurate time; but this one contains features that distinguish it from all others. In the first place, all the gears are high numbers, as compared with ordinary wheels. Where an ordinary gear would contain six teeth, a corresponding gear in this clock contains possibly sixteen. Again, as may be noticed, there are two weights, both for driving the pendulum, as there is no striking mechanism. In this arrangement a balancing effect on the first pinion of the train is obtained, as the first pinion is located between the two driving wheels, which turn with the winding drums, and thus it practically floats without pressure on the bearings. The object of this arrangement is two-fold—first, to secure a constant turning moment while the clock is being wound, and secondly, to reduce the frictional effect. Of course, while the clock is being wound the driving effect is only one-half of the ordinary amount; but this is practically sufficient to prevent any slowing down for the brief period required for the winding. The escapement is the ordinary dead-beat form, and a simple pendulum is used which approximates a compound pendulum in maintaining a constant length as it is made from a piece of California redwood. The co-efficient of expansion for this and some other woods is so minute that it is doubtful if it has ever been measured. The clock will indicate time from four places, as it has four dials, one below and three above, but, as at present arranged, all the faces indicate the same time. The motion is conveyed to the hands on the upper dials through a vertical shaft driven by helical gears, and the motion is transmitted from the vertical shaft to the hands by accurately cut bevel gears. It is easy to designate gears as being accurately cut, but often a test will show surprising inaccuracies in those which are supposed to be a superior product. In this case, however, any one could perceive a minute error, as it would be greatly magnified by the ratio of the gearing; but a close inspection by the unaided eye fails to detect any perceptible variation in the positions of the four sets of hands on their respective dials. The hands are made of aluminum, and the dials are graduated by an indexing machine; but, although each beat of the pendulum is easily perceived in the movement of each of the four minute hands, the constant register of all the hands is practically the same. Altogether this clock is an interesting specimen of clock-making done, not by a clockmaker, but by a mechanic, and it runs and keeps accurate time, not by reason of looseness of construction and makeshift expedients, but rather because of general mechanical excellence. The human skull to be seen on top of the case is an appropriate, though scarcely cheerful, reminder of the value of time and the inevitable fate awaiting us all.

Some Helical Gear Models.

The three models shown in Fig. 1 are specimens of the work the company is prepared to do, and the writer was informed that they also make models like those shown, or others, to order for technical schools, etc. The model appearing in the foreground is an interesting thing, as it shows beyond dispute that there is no dividing line between a worm and a toothed gear, but that one graduates imperceptibly into the other. The wheel on the left is what is usually designated as a worm, and has one tooth, or is a single-thread screw. The gear or worm wheel with which it is engaged has 32 teeth, so that 32 turns of the handle are re-

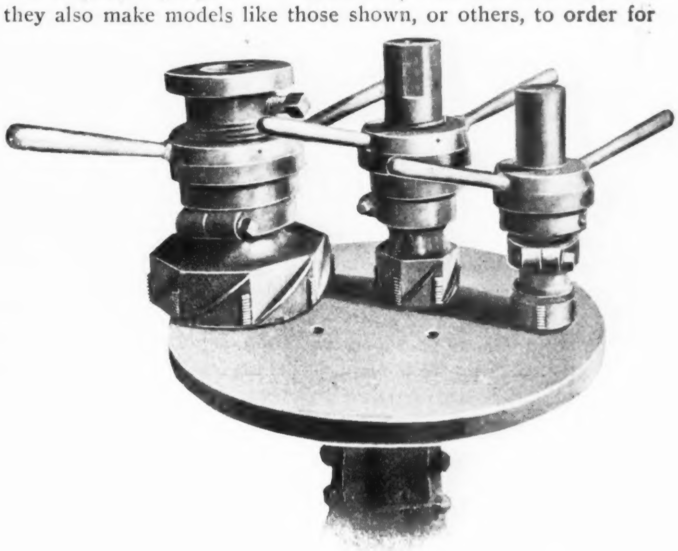

Fig. 2. Collapsible taps used in the shops of the Arthur Company, for tapping flanges, valves and similar work. The largest one shown measures 8 inches in diameter and has eight thread cutters.

quired to turn it around once. The next worm to the right has 2 teeth, which are therefore of double the pitch of the first, so that only 16 turns of the handle are required to turn the engaged gear one turn. The next worm has 4 teeth of double the pitch of the preceding worm, and as the engaged gear has the same number of teeth as in the previous instances, only 8 turns of the handle are required for one rotation. The next wheel has 8 teeth; conse-

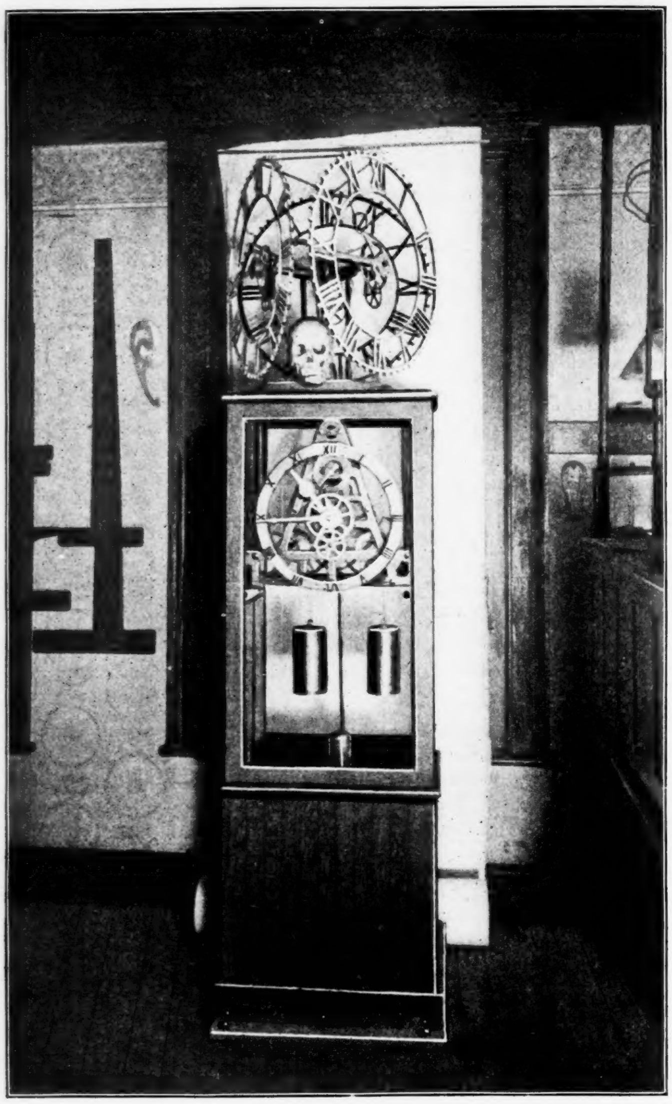

Fig. 3. The clock shown is an interesting example of accurately cut gearing, and contains, besides, some interesting mechanical arrangements. Eight feet high; upper faces 25 inches diameter.

quently only four turns of the crank are required for a turn of its mating gear. The next wheel, which looks suspiciously like a helical gear, has 15 teeth, and thus drives the engaged gear, which has 30 teeth, one full rotation with two turns of the handle. The last wheel in the row is undoubtedly a helical gear and has 24 teeth, with 24 teeth on the mating gear, giving an even ratio. In view of this model it is rather difficult to say positively what is a worm gear and what is a helical gear. Probably the principal difference between the two forms of gearing lies in the capacity of helical gearing to transmit motion from either member, so that either may be the driver gear or the driven one. A worm and worm-wheel mechanism as usually constructed, however, cannot perform this function on account of the excessive frictional effect, which prevents overrunning, a feature that is often its chief advantage.

Of the other two models shown in the group, little can be explained that is not shown by the photograph. This, however, does not do justice to the subject, as they must be seen in actual operation to appreciate the nicety of construction and the general novelty of appearance. The one at the right consists of four 45° helical gears, two of which are mounted on the same shaft. The lower two are, of course, right and left helices, as are the upper ones which engage with them. The different gears are interchangeable, so that various combinations can be effected. The model at the left is a combination of seven helical gears, the two horizontal shafts carrying three each, and one being shown in the foreground with its axis vertical. This gear can be removed and slipped on the horizontal shaft shown at the back of the frame, thus giving a combination of three helical gears with horizontal axes meshing together. It is obvious that a few models constructed on these lines give students in technical schools more practical information on the operation and possible combination of this style of gearing than will usually be readily learned from text-books. Practical models of this description also leave a more lasting impression, as the mind has a tangible subject to grasp. Many students have great difficulty in understanding the principles of helical gearing, as the difficulty of presenting the third dimension on paper makes the subject somewhat abstruse.

A Collapsible Tap.

In the manufacture of valves and flanges in large quantities, the usefulness of a collapsible tap is manifest on account of the ease with which sizes may be maintained or varied, and also the time saved in not being obliged to back the tap out of the hole being tapped. The three taps shown in Fig. 2 are part of the shop equipment for this work, and were designed and made for the class of work referred to. The largest one shown is 8", the next in size is 3½" and the smallest one is 2½" in diameter. All of them have thread cutters, like that shown at D in Fig. 4. In the main sketch, A is the body, or shank, which is threaded, as shown, and on which is screwed the collar B, bearing the handles HH. Below B is another collar, which can be gripped solidly on the stem of the tool by the clamping screw shown. The collar B in its movement up or down carries with it a cone-shaped piece, G, the end of which shows in the lower end view. This piece has as many slots as there are cutters, which is usually six or eight. The movement of G gives a positive movement to the cutters, the downward travel forcing them out and the reverse withdrawing them from the tapped thread. The collar C, is a stop to regulate the size of the thread tapped; the lower it is set the larger the thread, and vice versa. Minute differences can be made by a slight turn of C, and the wear of the cutters is easily compensated. If a workman desires to tap one hole somewhat smaller than the general run, and does not care to adjust the col-

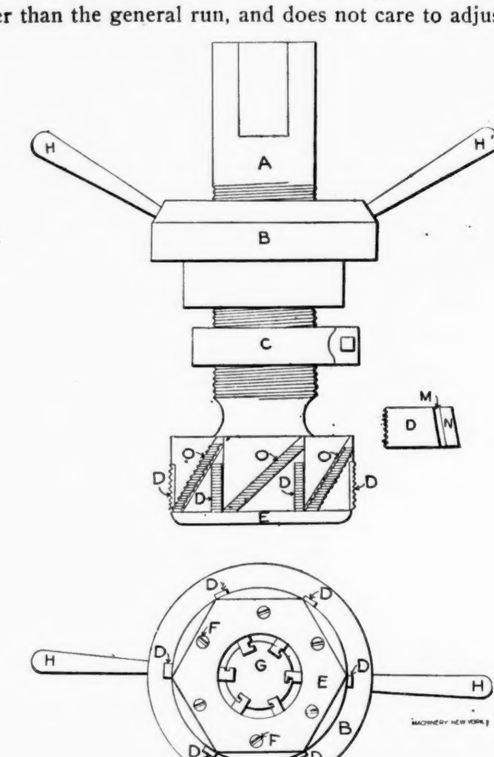

FIG. 4. A CUT GIVING SOME DETAILS OF THE COLLAPSIBLE TAP.

lar C, all that he need do is to insert a few thicknesses of paper or other material between B and C, which prevents the cutters from moving to their extreme outward position. Although this tap is quite simple and contains no parts liable to be easily injured, its success undoubtedly hinges on the shape of the inner end of the cutters. As shown at D in Fig. 4, the end, N, makes an angle with the sides that approximates the angle of repose, so

that, while the slotted cone G carries the thrust of all the cutters, the resistance to movement is slight, and no trouble ensues when attempting to back the cutters from the tapped hole. If the angle of the sides of G be greater or lesser than the stated angularity, there is a wedging effect that often requires the extreme efforts of the workman to disengage the tap. Another important feature is the diagonal lands O O O which extend to the nominal diameter of the tap and are therefore threaded but,

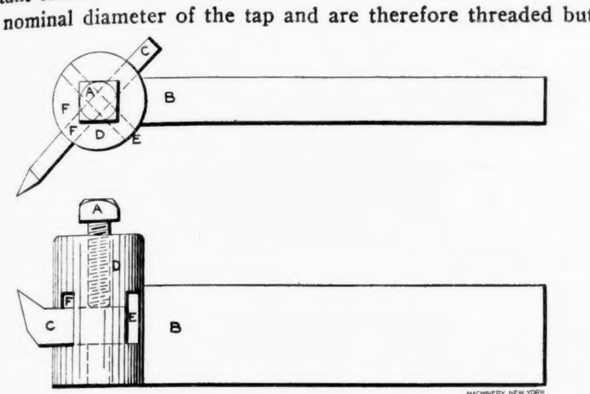

FIG. 5. TOOL HOLDER.

being of soft steel, of course do no cutting. They are oil distributors and fulfill the function very neatly, distributing the oil *behind* the cutter, instead of in front of it, to be immediately swept away. By the time the advancing cutter has reached the lubricant, it is well distributed over the surface and therefore gives the maximum lubricating effect.

Lathe Tools.

The lathes in the shop are provided with a neat form of toolholder, which is shown in Fig. 5 and which will be seen to possess considerable merit. The holder consists of the shank B, and the bulb D, which is slotted for two positions of the tool, one being at right angles to the other. A tool may be in position for facing, and it may be removed for a boring tool, which is placed in the other slot. The change can be made without disturbing the position of the holder in the tool-post, which is considered of considerable practical value. Square center reamers are used for centering work, the form used being shown in Fig. 6. The shank of the tool is of soft steel, with a hole clear through, and has a collar with the set screw A. Square steel is used for the center C, which obviously makes a cheap and easily maintained tool. All the lathes are provided with two pairs of centers, one pair having the ordinary 60° angle and the other pair having their points turned to 90°. The latter are used on hurry-up and rough jobs, on which the time is not taken for relieving the centers. As much of the work done in the repair line is of an emergency character for steamships, tugs, etc., anything that will save a few minutes of time on a job is well worth considering.

Interchangeable Chucks and Face-plates.

All the lathes, drill-presses and milling-machine fixtures take the same sized centers in the respective classes, so that drills, reamers and centers are interchangeable. The lathes in the 13", 16", 20" and 30" classes interchange chucks, so that any 16" lathe can take any of the chucks in the shop that are threaded for that sized lathe. Although this system often requires that new lathes

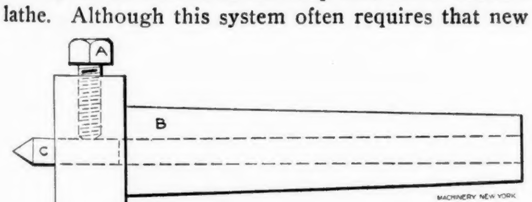

FIG. 6. SQUARE LATHE CENTER WITH REMOVABLE CUTTER.

be made to order, or that they be provided with a special spindle, the benefits resulting from it are of much value. The number of chucks required for the shop equipment by this system is not large, yet each lathe can use a large variety of chucks without interference with the other machines, as duplicates are, of course, provided in those sizes which are most used. Mr. Arthur is a strong advocate of the interchangeable system and would extend it to the manufacture of general machine parts by various makers, so that, as in this case, chucks, face-plates and other nose tools could be used on any maker's tools in the various classes.

THE NEW PRESIDENT OF THE A. S. M. E.

CHARLES HILL MORGAN.

Charles Hill Morgan was born in 1831 of New England parents. His early education was acquired in the Massachusetts' district school, which he attended until he was twelve years old when he was obliged to work in a factory. Some years later he took a course in mechanical drawing, working at night, as he was busy in the shop during the day. These few lessons, however, proved of great value to him in after life. In 1852 Mr. Morgan was put in charge of the Clinton Mills Dye House. Later, from 1855 to 1860, he was mechanical draughtsman for Erastus B. Bigelow, inventor and manufacturer. In that capacity, he introduced a system of designing and constructing cam curves for looms.

In 1864 he became superintendent of manufacturing for the firm of Washburn & Moen, Worcester, Mass., and four years later was made general superintendent. He then made seven different trips to Europe and visited the mills of England, France, Germany, Belgium and Sweden, acquiring a vast amount of valuable information and many ideas which were of great benefit to the firm. One of the inprovements in the wire business with which Mr. Morgan was connected was the development of the continuous rolling-mill originally built by George Bedson, Manchester, England. His first important improvement on this mill was a power reel; the second, the introduction of a continuous train of horizontal rolls. The original rolling-mill had horizontal and vertical axes alternately. The improved mill, consisting of a series of horizontal rolls with intermediate twist guides between them, giving the metal one-quarter of a turn in its passage from one pair of rolls to the next, was far superior to the old one.

Since 1887 Mr. Morgan has been associated, as president, with the Morgan Spring Co., manufacturers of wire and springs, and with the Morgan Construction Co., Worcester, Mass., manufacturers of rolling-mill and drawing machinery. The latter especially, have been most successful, and their designs and machinery are being adopted by many. They have given special attention to the continuous rolling of billets, merchant bars, rods and hoops, and developed the continuous method of heating billets, and finally introduced the continuous gravity discharge furnace, the invention of Mr. Morgan.

Besides the active part he takes in all that concerns his immediate business affairs, Mr. Morgan is a member of the Board of Trustees of the Worcester Polytechnic Institute, in whose growth and success he is greatly interested. He is also a member of the British Iron and Steel Institute and of the American Institute of Mining Engineers

TWENTIETH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The twentieth annual meeting of the American Society of Mechanical Engineers, which was held in New York from December 5 to December 7, was the largest and one of the most successful that the society has had. There were over 700 names registered. On Tuesday evening, December 5, Admiral George W. Melville delivered the president's address upon "Engineering in the United States Navy." On Wednesday morning the usual business was transacted and a few professional papers were read. The report of the council showed that there are now 1,957 members of all grades, and it was announced that among the special business matters to be considered were the erection of a memorial to Robert Fulton in Trinity churchyard, New York, for which $900 have already been subscribed, and the arrangements for the proposed European trip of the society at the time of the Paris exposition. Since this meeting, a notice has been sent to the members of the society giving particulars about this trip. Prof. Unwin of England, the well-known authority on machine design, was elected to honorary membership. A number of duplicate books from the library have been presented to the University of Virginia, which recently sustained a heavy loss from fire. The society has acquired two valuable collections of books owned by former members, and a water-color drawing bearing the signature of Robert Fulton and showing an aqueduct scheme for carrying a canal across a river has also been presented to the society.

Of the various committees appointed the one that has been at work so long upon the code for boiler trials presented its completed and revised reports. The one appointed last May to consider the matter of standard dimensions for direct connected generators and steam engines will probably present a report at the next meeting, and the committee upon steam-engine trials will also be prepared to report at a later meeting.

The president elected for the coming year is Mr. Charles H. Morgan, of the Morgan Construction Co., Worcester, Mass., a sketch of whose life appears elsewhere. It is probable that the next meeting will be held in Cincinnati, in May.

THE STEAM ENGINE AT THE END OF THE NINETEENTH CENTURY.

At the conclusion of the business Prof. Robert H. Thurston presented the first professional paper of the session upon the progress of steam-engine economy during the past century, with special reference to a recent test upon a quadruple expansion pumping engine built by the Nordberg Mfg. Co. This engine holds the world's record for pumping engines, having a duty of 162,984,824 foot-pounds per 1,000,000 B. T. U., as against 150,100,000 foot-pounds realized by an engine built by the Snow Steam Pump Works, which previously stood a little higher in the scale than any other engine. It gave this duty, too, with a consumption of 12.26 pounds of steam per horse power per hour, whereas the Snow engine used only 11.26 pounds. This seeming paradox is due to the peculiar arrangement of the engine, whereby a quantity of steam from the jackets and receivers is led to a series of feed-water heaters, with the result that the feed-water is brought to nearly or quite the temperature of the steam in the boiler, before it enters the boiler. Thus, while this engine nominally consumes more steam than several others, the loss is more than balanced by the heat that is returned to the boiler in the feed-water, and the net result is a gain in thermal efficiency.

This paper is extremely valuable, but it is too elaborate to permit even an abstract to be given here. In the Nordberg engine the attempt is made to operate upon the so-called "regenerative cycle," proposed by Prof. Cottrell, and the theoretical side of the subject is treated fully by Prof. Thurston. He also gives elaborate tables of engine performances, and among other diagrams, one showing the steady improvement in economy and the reduction of internal wastes of the best engines from 1750 to 1900.

In the discussion Charles T. Porter requested that the record of engine performances for this century be not closed until the end of the coming year, the last year of the century. He said that he expected to produce an engine that would operate on 9 pounds of steam per horse-power per hour, and in response to an enquiry as to how this was to be accomplished, said, mainly by the use of high pressures and by jacketing the cylinder barrels, heads, valves and pistons of the engine. Mr. Porter is one of the few who have really made steam-engine history during the nineteenth century, and it would be a fitting close of the century and a merited accomplishment should he succeed in the results that he hopes to accomplish.

OTHER PAPERS.

C. V. Kerr, Chicago, Ill., next read a paper on the Berthier Method of Coal Calorimetry, and urged that this method be more generally used than that of Mahler's bomb calorimeter which is recommended in the committee's report upon the code for boiler testing. Prof. J. E. Kinealy, of St. Louis, contributed a written criticism of the Berthier calorimeter, in which he held that it was not adapted to the general use to which Mr. Kerr proposed to put it.

John A. Laird, St. Louis, Mo., reviewed tests made upon two 10,000,000 gallon pumping engines constructed by the E. P. Allis Co. for the St. Louis Water Works. The engines are three cylinder triple expansion, condensing, vertical, with rigid connections between plungers and pistons and three single-acting plungers. The diameters of cylinders are respectively, 30 inches, 54 inches and 80 inches. The plungers are 25½ inches in diameter, and all are 64 inches stroke. There are two receivers, the heating coils inside of which are helical and extend for the full length of the receivers. The cylinders are jacketed on the sides, but not on the heads. The results of the tests contain the following items:

Feed-water per I. H. P. per hour, lbs.	11.648	11.653
Dry steam per I. H. P. per hour, lbs.	11.627	11.632
Duty per million British thermal units, ft. lbs.	143,404,000.	144,365,000.

A calculation of the pressure in a pipe due to the stoppage of a flowing liquid was presented in a brief paper by George M. Peek, New York City. His method is to first find the increase due to sudden stoppage, taking into account the comprehensibility of the liquid and the elasticity of the pipe by equations which he deduces, and then add to this the static pressure due to the head, and also a pressure due to twice the velocity head and the friction head.

There was also at this session a paper by H. T. Eddy, containing a new graphic method of constructing a temperature-entropy diagram.

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THE THIRD SESSION.

COMPRESSION AND LIQUEFACTION OF GASES.

The paper by Arthur L. Rice, Brooklyn, N. Y., upon the compression and liquefaction of gases, was the first one read at this session. It gives an historical and descriptive account of the efforts that have been made at the liquefaction of the various gases, concluding with an interesting account of the means that have been adopted for producing liquid air. Diagrams, with descriptions of the apparatus used by Linde, Hampson, Dewar and Tripler are shown, and the following extract from the paper gives an account of the work of the latter investigator, in connection with liquid air:

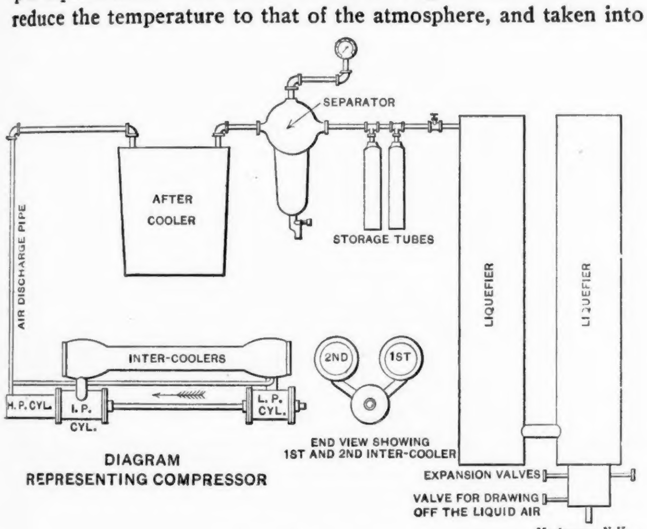
Although liquid air has received considerable attention from different investigators, Tripler, Linde and Hampson should be mentioned as having been aiming at the simplification and cheapening of the production, so that the liquid may be made of use. All three have been working along the lines of a direct regenerative action, as suggested by Siemens. Dewar has also done work along this line, combined with cooling by a separate fluid, but in a smaller way as would be expected in a chemical laboratory. The principle is this: a perfect gas expanding to do work loses heat; if this cooled gas be exhausted so as to jacket the pipe through which the incoming gas enters, it will cool that incoming gas; the process is cumulative without limit, if the machinery

is frictionless and insulated against heat from the surrounding objects. Solvay built a machine on this principle, but was unable to get lower than — 139 degrees Fahr. (95 degrees C.), on account of the heat due to the friction of the pistons and to conduction.

In a perfect gas, no lowering of the temperature would result from lowering of the pressure by free expansion, but none of the so-called gases are perfect, and all are cooled somewhat by expansion through an orifice. Joule and Kelvin found that with air the fall of temperature is about 6.45 degrees Fahr. (¼ degree C.) for each atmosphere difference of pressure at the orifice, at ordinary temperatures, and that the effect increases as the temperature falls, because the gases are coming more nearly to the vaporous state. If then, air be compressed to a high pressure and be allowed to expand through a small orifice, it will become considerably cooled and may be used to cool the incoming air which, in turn, will lose heat by expansion; the process may be carried on until some of the air, on or before leaving the orifice is liquefied.

Tripler's English patents of 1891 seem to be the first specification of any definite machinery for thus liquefying air.

Mr. Tripler's apparatus, shown in the accompanying sketch, consists of a three-stage compressor drawing air directly from the atmosphere and driven by a steam engine. The air is taken first into the low-pressure cylinder, where it is compressed to 65 pounds per square inch. It is then sent through an intercooler to reduce the temperature to that of the atmosphere, and taken into



TRIPLER'S APPARATUS.

the intermediate pressure cylinder. From that, at a pressure of 400 pounds, it is taken through a second intercooler to the high-pressure cylinder, where it is forced up to 2,000 to 2,500 pounds and thence sent to the aftercooler to be reduced again to the temperature of the atmosphere. The air is passed through a separator to take out all moisture and then passes to storage tubes in which compressed air, not in the liquid form, may be kept. The liquefier is Mr. Tripler's special invention. It takes the air from the separator and, by expansion through a coil of pipe and a small orifice, cools it to a low temperature, then passes up around the coil of pipe, cooling the air inside and thus giving the regenerative action. The expansion valve is placed at a little distance above the bottom of the coil, so that some liquid air collects in the bottom of the coil, and thus serves to further cool the air as it comes to the expansion cock. The air which is to be drawn off collects in the liquefier just below the expansion valve, and may be drawn off at will. The expanded air escapes to the atmosphere after having been used to cool the coil of the liquefier. The capacity of the present plant is two to four gallons per hour, and the air will begin to liquefy in fifteen minutes after starting up. No data are available as to the power used in the compression .

BLUE-PRINT FRAME.

In a brief paper Paul Mellen Chamberlain of Chicago, described a novel blue-print frame. He said: The desirable features of a blue-print machine are ease and rapidity of operation, such adjustment as to secure the direct rays of the sun, and

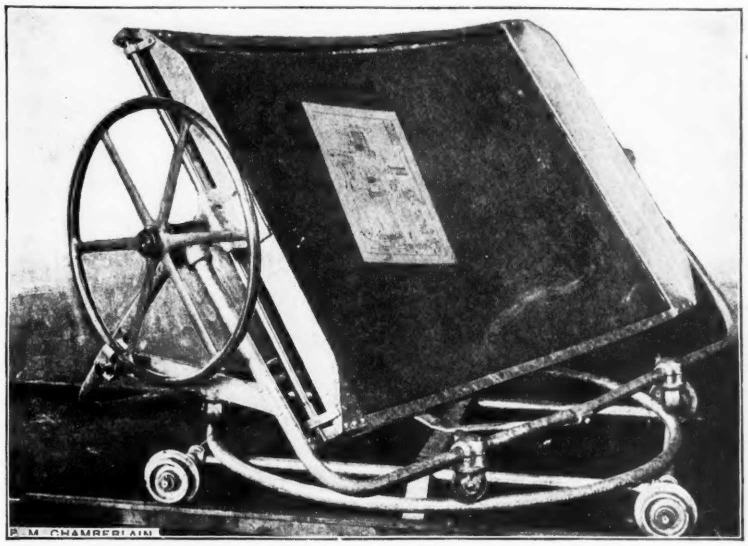


FIG. 1. NOVEL BLUE-PRINT FRAME.

means whereby close contact between the tracing and the sensitized paper may be secured. The machine here described and illustrated was designed to meet the above requirements, and was first built for, and in the shops of, the Lewis Institute.

The operation of the car and the universal adjustment is so clearly shown in Fig. 1 that explanation seems unnecessary. The iron work is all galvanized to avoid rusting after exposure to rain or snow. The glass is curved to a radius of thirteen feet. Attached to one end of the frame is a sheet of canvas-rubber packing about one-thirty-second of an inch thick. The other end of the rubber cloth is fastened to a steel tube which serves as a roller to roll cloth on and also as a stretcher.

The operation is this: The rubber cloth is rolled back on the steel tube, and the paper and tracings are placed on the convex side of the glass; the cloth is unrolled with one hand, leaving the other free to adjust or turn down crumpled edges of the tracing, as shown in Fig. 2, the ends of the steel roller are engaged by hooks operated by cams at the end of the frame, and a turn of the handle stretches the cloth, giving a pressure component normal to the glass; the frame is turned over, the car pushed out of the window, and the frame adjusted to the proper angle with the sun's rays. The operation is rapid, the placing of tracings very easy, and the contact obtained between tracing and paper all that could be desired.

Another paper by Mr. Chamberlain described an apparatus

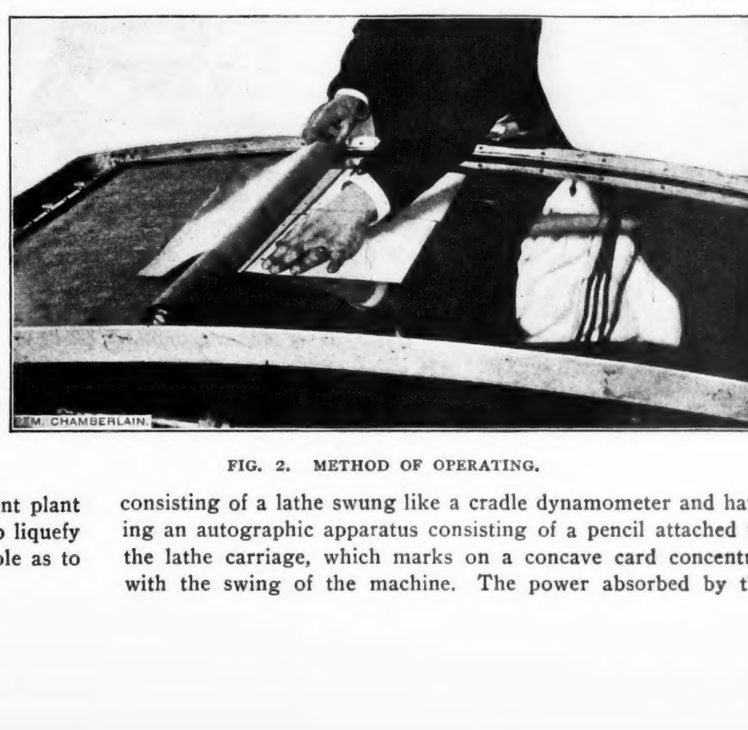


FIG. 2. METHOD OF OPERATING.

consisting of a lathe swung like a cradle dynamometer and having an autographic apparatus consisting of a pencil attached to the lathe carriage, which marks on a concave card concentric with the swing of the machine. The power absorbed by the

tool in cutting is thus accurately indicated by the tracing made by the pencil. The experiments made up to the present time show that the pressure on the tool is independent of the cutting speed and the metal removed is proportional to the pressure.

The education of machinists, foremen and mechanical engineers formed the subject of a paper by M. P. Higgins of Worcester, Mass., which closed the evening's proceedings and again introduced the much-debated question of technical education. The paper attracted marked attention and was discussed at length by many members. The paper and discussions cover too much ground to be summarized here, and further reference to them will be deferred until a future issue. It is expected that more discussion of the topic of techinal education will be introduced at the next meeting of the society.

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FOURTH SESSION.

On Thursday morning the first paper was by Herman Poole of New York, upon using gasoline gas for boiler heating. The boiler used was of tubular pattern, with heating surface and grate area in the ratio of 26 to 1, and 1,211 pounds of water were evaporated from and at 212 degrees by 35 gallons of gasoline. This is at the rate of 34.7 pounds of water per gallon of oil, or about one boiler horse-power was generated per gallon. Compared with the gasoline engine, which uses only a fraction of this quantity of oil per horse-power, the results make rather a poor showing.

PACKING TESTS.

The next paper was upon the subject of the friction of steam packings, by Prof. C. H. Benjamin, of Cleveland. It outlined tests that have been made at the Case School of Applied Science with a special apparatus designed for this purpose. The apparatus consists of a cast-iron cylinder, 6x13 inches inside, fitted at each end with a cover and stuffing box suitable for a two-inch rod. The rod was given a reciprocating motion by means of

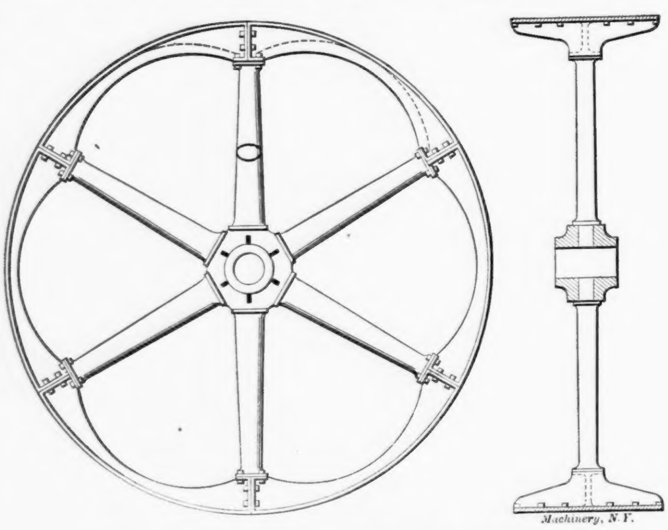


FIG 1. SUGGESTED IMPROVEMENT IN FLY-WHEELS.

a slotted cross-head and crank; a pulley on the crank was connected by a belt with the pulley of a transmitting dynamometer; steam was admitted to the cylinder by a pipe, and the water of condensation was drained off from time to time at the bottom.

A steam gauge attached to the cylinder showed the internal pressure at any instant. The adjusting nuts of the gland were usually tightened only by the fingers, but where a wrench was used it was turned by a spring balance and the turning moment noted. The travel of the rod was 4.25 inches and the usual speed about 200 revolutions per minute, giving a piston speed of about 140 feet per minute.

The conclusions drawn from the test are that

1. The softer rubber and graphite packings, which are self-adjusting and self-lubricating, consume less power than the harder varieties. Old braided flax style, gave very good results.

2. Oiling the rod will reduce the friction with any packing.

3. There is almost no limit to the loss caused by the injudicious use of the monkey-wrench.

4. The power loss varies almost directly with the steam pressure in the harder varieties, while it is approximately constant with the softer kinds.

It was objected by some who joined in the discussion that the methods of making these tests did not conform nearly enough to actual practice, and the suggestion was made that the most satisfactory determination of the friction of a packing was by measuring the wear of the rod in a given time.

Following this paper came a report of tests of a locomotive slide valve, by Frank C. Wagner, Terre Haute, Ind., showing that from 1½ to 3 1-3 horse-power were required to operate the valve.

THE SUBJECT OF FLY-WHEELS.

A Note on Flywheel Design, by A. J. Frith, New York City, was a comment on the peculiar action of a flywheel, described before a previous meeting of the society. The wheel had speeded beyond the safe limit and cracked in several places where the arms joined the rim, although it did not go to pieces. Mr. Frith contended that this action was due to the arms and rim not being proportioned so that both would have the same unit stress when running, and that if a wheel were so proportioned, it would be much safer, because all of its parts could extend to the same scale, so to speak. This condition cannot be brought about

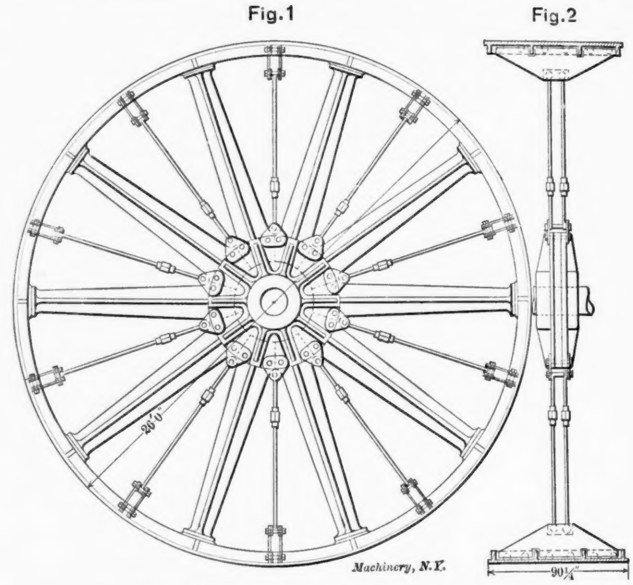


FIG. 2. METHOD OF REPAIRING FLY-WHEEL.

in a wheel as ordinarily designed, owing to the fact that the tension in the arms from centrifugal force must necessarily be less than in the rim. It can be accomplished, however, by making the rim thicker at the arms than midway between the arms, and it is the author's suggestion that the ribs of the rim be curved gradually from arm to arm on the sides next the hub, as shown in Fig. 1, this curve being made to conform to the natural catenary curve, which the particles would take if left free to arrange themselves as the forces induced. The part of the curve next the arms should make an angle of 60 degrees with the center line of the arms.

Mr. James McBride, Brooklyn, N. Y., described how he repaired a large flywheel and brought out in a very practical way the point that was made in the previous paper by Mr. Frith with regard to the danger arising from the bending of the rim between the arms of the pulley. The flywheel in question was a large Corliss wheel, weighing between thirty and forty tons, carrying two belts, one 48 inches wide and another 34 inches wide. The broad rim for these belts was supported by only one set of arms which were bolted between two central discs serving the purpose of hubs at the center and bolted to the rim midway between the rim joints at their outer ends. The engine ran away, owing to defective action of the governor, and several cracks appeared in the rim near where the arms were joined and which were clearly due to the bending of the rim, as above mentioned. The wheel was repaired between the times when the engine was shut down, amounting to only four hours a day, and when finished was undoubtedly stronger than originally. The method of repair is shown in Fig. 2, and was to attach plates to the flanges of the rim where the segments were bolted to-

gether and also to the hubs midway between where the arms joined them. These plates were then connected by tie bolts or tension rods that were strong enough to take the strain of the centrifugal force of the parts of the rim between the arms. The construction of the wheel was such that these changes could be made without drilling new holes, and the details were worked out in an ingenious manner at a cost of less than $500.

GAS ENGINE TEST.

A report of an efficiency test of a 125 horse-power gas engine formed the subject of a paper by C. H. Robertson, Lafayette, Ind. The test was made in a plant using natural gas costing .07 cents per thousand feet, but so arranged that gasoline vapor can be used if the gas from the main is for any reason shut off. The jacket water is cooled by means of a cooling tower consisting of tiling piled loosely in a large tank, through which the water trickles and is used over again. The exhaust pipe is conducted underground to a cistern under the building open to the air through a tile 10 inches in diameter. The tests were made to determine the power developed, the gas consumed, the speed regulation and such incidentals as the heat given to the jackets and the temperature of the exhaust. The gas measurements were reduced to equivalent quantities of gas at 14.7 pounds pressure and 62 degrees Fahr., as is necessary in order to make fair comparisons with the performance of other engines. The following average results were obtained: Average indicated horse-power, 88.79; brake horse-power, 73.27; gas per indicated horse-power hour, 14.18 cubic feet; gas per brake horse-power hour, 17.96 cubic feet; thermal efficiency of engine, 14.6. The engine ran at 270.8 revolutions per minute, and was in ordinary working condition, no effort having been made to have it in better than average condition. The engine, also, is of old style and probably is not so economical as more modern ones.

In the discussion it was pointed out that the engine was designed chiefly to regulate closely with a variable load, and that it was not operating at full capacity, which conditions were adverse to economy. The test showed that the proportion of waste in the jacket was about the same as in small engines and the fact that the temperature of the exhaust gases of this engine are so hot that the exhaust pipe glows at night called out the story of a gas engine, which was reputed to be running under such adverse conditions that the exhaust gases were made to operate a boiler which generated steam for an engine of more power than the original gas engine!

STRENGTH OF STEEL BALLS.

The results of tests made at the Rose Polytechnic Institute upon steel balls were reported by J. F. W. Harris. Balls were procured of sizes ranging from ½" to 1" in diameter from six manufacturers and the attempt was at first made to test the balls by crushing between hardened steel plates. Difficulty was experienced, however, in procuring steel so hard that it would not indent under the pressure to which it was subjected in contact with the balls, and the plan was adopted of placing three balls in a row in a special holder, which kept them in line axially. Pressure was then brought to bear upon the two outer balls, eventually crushing the middle one. After this series of tests was completed, a steel was found that answered the purpose for testing the balls between flat surfaces and another line of tests was conducted with the balls between two flat plates of this steel. A singular fact is that in the first series nearly all the balls were broken by the formation within the ball of a conical wedge which was gradually forced toward the center of the ball until the latter was split. The base of the cone was approximately circular, with its center at the point at which the crushing force acted. The following table gives average results of the two series of tests. It will be seen that the values in the last horizontal row are higher than in the second row, showing that the balls withstood more when tested between flat plates than when they had the point contact, simply, of the first test.

BREAKING PRESSURE IN POUNDS.

Diameters.	Strength.					
	⅛	¼	⅜	½	⅝	1
Between two balls	2,000	4,000	8,000	15,000	22,000	60,000
Between flat plates	2,000	5,000	12,000	20,000	32,000	90,000

In discussing this paper Oberlin Smith suggested that the subject be taken up more extensively and treated not only experimentally, but from a mathematical standpoint, as well. To this Mr. Pratt, of the Sprague Elevator Co., said that he thought very little could be done mathematically because there was a lack of uniformity in the strength of the balls that are now to be had, and until they gave uniform results under test, no theoretical considerations would hold true.

COLORS OF HEATED STEEL.

Maunsel White and F. W. Taylor gave the results of extended experiments upon colors of heated steel corresponding to different degrees of temperatures, which are briefly summarized in the following quotation from their paper:

The temperatures corresponding to the colors commonly used to express different heats, as published in various text books, hand books, etc., are so widely different as given by different authorities, it is impossible to draw any definite or reliable conclusion. The main trouble seems to have been in the defective apparatus used for determining the higher temperatures. The introduction of the Le Chatelier pyrometer, within the last few years, has placed in the hands of the scientific investigator, an instrument of extreme delicacy and accuracy, which has enabled him to determine temperatures through the whole practical range of influence.

The nomenclature used for color heats differs with different operators, but in our investigation we have adopted that which seems more nearly to represent the actual color corresponding to the heat sought to be represented. We have found that different observers have quite a different eye for color, which leads to quite a range of temperatures covering the same color. Further, we have found that the quality or intensity of light in which color heats are observed—that is, a bright sunny day, or cloudy day, or the time of day, such as morning, afternoon, or evening, with their varying light—influence to a greater or less degree the determination of temperatures by the eye.

After many tests with the Le Chatelier pyrometer, and different skilled observers working in all kinds of intensity of light, we have adopted the following nomenclature of color scale with the corresponding determined values in degrees Fahr. as best suited to the ordinary conditions met with in the majority of smith shops:

Dark blood red, black red	990°
Dark red, blood red, low red	1,050°
Dark cherry red	1,175°
Medium cherry red	1,250°
Cherry, full red	1,375°
Light cherry, bright cherry, light red (heat at which scale forms.)	1,550°
Salmon, orange, free scaling heat	1,650°
Light salmon, light orange	1,725°
Yellow	1,825°
Light yellow	1,975°
White	2,200°

With the advancing knowledge of, and interest in, the heat treatment of steel, the foregoing notes, it is hoped, may prove of some value to those engaged in the handling of steel at various temperatures, and lead to further and wider discussion of the subject, with a view to the better understanding and more accurate knowledge of the correct temperatures. The importance of knowing with close approximation the temperatures used in the treatment of steel, cannot be over-estimated, as it holds out the surest promise of success in obtaining desired results.

This demand for more accurate temperatures must eventually lead to the use of accurate pyrometric instruments; but at present the only available instruments do not lend themselves readily to ordinary uses, and the eye of the operator must be largely depended upon; therefore, the training of the eye, by observing accurately determined temperatures, will prove of much material assistance in the regulation of temperatures which cannot be otherwise controlled.

* * *

CLOSING SESSION.

The session on Friday morning was the last, and among the excellent papers that were read the one by Walter C. Kerr, New York City, deserves special mention, although it will not be possible to give an abstract of it. It described and illustrated the mechanical equipment of the New South Station at Boston, Mass., which in many respects is the most remarkable station in the world. This paper had many illustrations and diagrams

and over 100 pages of text. It was prepared jointly by the different engineers who were engaged upon the installation, and is a valuable record of a great engineering enterprise. A peculiar feature about this plant is that it was designed and contracted for, complete, by one firm of engineers and manufacturers, Westinghouse, Church, Kerr & Co., and this fact caused considerable discussion as to whether this practice was as desirable as employing engineers not connected with the construction of the apparatus and machinery.

W. J. Keep, Detroit, Mich., opened this session by describing an extensive series of tests upon the effect of impact upon test bars, which also is not susceptible of satisfactory condensation, and those interested should refer to the paper itself.

GAUGE FOR HIGH PRESSURES.

F. H. Stillman, New York, gave an interesting account of experiments that had been performed at the West Virginia Agricultural Experiment Station with a small press that his firm had built for obtaining high pressures, 450.000 pounds having actually been attained. In connection with this he outlined a method for measuring these enormous pressures with great accuracy, which is at once so simple and so interesting that we quote the following:

"These pressures may be determined by a picnometer bottle which differs from an ordinary glass-stoppered bottle only in that the top of the stopper is expanded into a little bowl or cup which, when the stopper is in position, communicates with the interior of the bottle by means of a very fine capillary hole through the stopper, is weighed accurately, empty, then weighed full of mercury, which, of course, gives the weight of the volume of mercury necessary to fill the bottle. The mercury is then poured out and the bottle filled with the liquid whose compressibility is to be determined, the stopper inserted firmly, and a quantity of mercury poured into the little cup. Although the mercury is much heavier, of course, than the liquid (*e. g.* for example, water) in the bottle, the mercury cannot enter the bottle, because the water and mercury cannot pass each other in the capillary hole. Any difference in pressure, however, will allow either the mercury to flow into the bottle, or the liquid within the bottle to flow out, depending upon whether the pressure is higher without or within the bottle. The little bottle loaded in this way (with mercury in the cup, and the liquid whose compressibility is to be determined in the bottle) is placed under pressure in the usual way, when just enough mercury will enter the bottle (and fall to the bottom) to make up for the compression experienced by the liquid (water) in the bottle under the pressure applied. On removing the pressure a quantity of the liquid (not the mercury) will be forced out through the stopper; but this does not matter, as everything is estimated in terms of the mercury, which is then poured out, dried, and weighed, and from the weight of this quantity of mercury and the weight of the quantity required to fill the bottle the compressibility of the water liquid is estimated.

"By means of these little picnometer bottles the compressibility of any liquid may be determined under any pressure up to that of the crushing strength of steel, and having determined, once for all, the compressibility of mercury and of some other liquid, preferably water, this method can be used to determine with great accuracy the pressure on the liquids in hydraulic machinery, etc.

"It would only be necessary to load one of these little bottles with water and mercury, as described, and place it in a tube communicating with the liquid in the hydraulic machine. In this proposed gauge the accurary depends solely upon the elasticity of the water and mercury and the balance used in the weighings, and liquids are perfectly elastic; and the analytical balance has reached about as high a degree of perfection as any instrument known to science. The accuracy or delicacy of this gauge hinges upon determining volumes by weighing mercury, and there is hardly a determination known to science that can be made with greater accuracy. The quantities of mercury to be weighed would, of course, depend upon the size of the bottle used; but even when working with a bottle two inches long by three-fourths of an inch in diameter, the quantities of mercury are sufficient to enable a reasonably good balance to detect differences in pressure of a pound throughout the range of the several hundred thousand pounds mentioned."

The last paper of the closing session was "On the Value of a Horse-Power" by George I. Rockwood, of Worcester, Mass. The water boards of our cities are acquiring by legislative processes streams now yielding water power for industrial purposes; and it is of the greatest importance, alike for mill owners and water commissioners, to have a rational basis upon which to adjust the losses due to the confiscation of such powers. This paper does not attempt to propose a basis for adjustment, but simply summarizes the difficulties experienced by the city of Worcester during the past year in settling with the owners of developed privileges along the Blackstone River, part of the waters of which the city has taken for the city water supply. The power owners claimed that a horse-power is a piece of property which may be considered to have a definite market value, and that the settlement should be on the basis of this market value. The city, however, claimed that a horse-power could not be considered as a commodity and that what the owners had lost by the diversion of water was simply the right to generate power and that they should be compensated by a sum sufficient to generate this power by other means continuously.

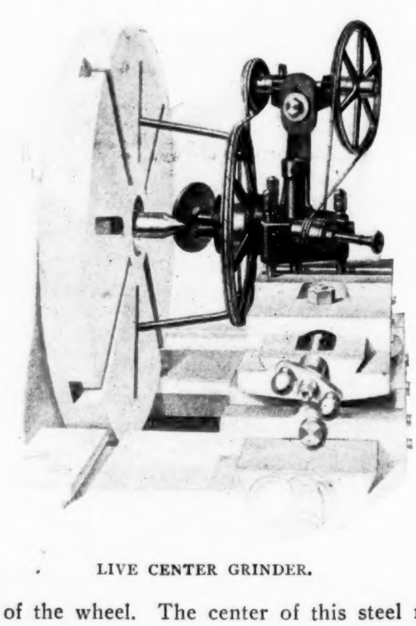
This paper was discussed freely and a motion was finally made and carried, for the appointment of a committee to consider the subject and formulate definite principles that might serve as a guide in future disputes of this nature.

* * *

SIMPLEX CENTER GRINDER.

The simplex center grinder, shown in the accompanying illustration, is manufactured and patented by Herman Dock, Philadelphia, Pa., and is named from the ease with which it can be adjusted to the lathe, and its simplicity of construction. It has a triangular shaped body, having a hub on which revolves the driving wheel as shown in the illustration. Through the center of this hub, at an angle of thirty degrees, is the bearing of the grinding spindle, which is driven through the intermediate pulleys and the belts, connecting this spindle with the driving wheel.

The driving wheel is connected with the face plate by a steel rod bent in the form of a U and having two arms engaging the face plate and which are thus free to rock in bearings on opposite spokes of the wheel. The center of this steel rod is bent into the form of a half-ring so that it clears the hub of the wheel. This makes a compensating device which gives a constant driving speed regardless of the position of the cross slide with respect to the center of the lathe. The grinder spindle is uncovered, but there is no danger of cutting, for during its forward and backward motion an efficient wiping device keeps out all grit. It is said that it takes only one minute to set the simplex grinder on the average lathe and that the average centers can be ground in about two minutes. It can be used so easily that it enables a shop to secure the advantages of hardened live centers without any trouble in keeping them in proper condition.



LIVE CENTER GRINDER.

GAS ENGINE DESIGN.—2.

DIRECTIONS FOR LAYING OUT AN IDEAL DIAGRAM.

E W ROBERTS.

The principal dimensions of a gas engine and those upon which a great many of the other dimensions are based, are the diameter of the cylinder and the length of the stroke. While there are several ways in which these dimensions may be determined, the most rational one is from the mean effective pressure and the speed, i. e., the number of revolutions made by the crankshaft in one minute. In order to obtain the M.E.P. with any degree of certainty the indicator diagram should be laid out and the M.E.P. obtained from that. This may seem a difficult task, and to a certain extent it is; but a very close approximation to the actual diagram can be obtained with a little care, and when obtained, this diagram will be found a very good index to the behavior of the gases at the various points of the cycle. The writer will give, in addition to the method of building up this diagram, a general formula applicable to this problem. He believes that the designer who wishes to make a basis of the matter of the behavior of the gases will find much to aid him in the diagram.

In designing a gas engine it is usual to base its dimensions on what its performance will be when using either gasoline or natural gas and to deduce from these figures its output when working with fuels of less heat value. The writer will therefore show how to build up the diagram for an engine using natural gas of average quality. By reference to Fig. 2 (Part I.) it will be seen that the diagram consists of two curves and a straight line. The compression curve is the first part of the diagram to be produced, then the straight line denoting the rise of pressure due to the explosion, then the compression curve and lastly a small curve denoting the fall of pressure after release. This latter curve is of little moment and will be considered only as indicating approximately the point of release. It is in determining these curves that the principal part of the work is done. They are determined from formulas requiring the use of logarithms and in order to enable those unfamiliar with handling logarithms to build the curves, the calculation of a sample diagram will be given.

Before making the computations for the diagram it is necessary to decide either upon the proportion of the compression space to the displacement of the piston or upon the pressure that it is desired to have after compression. In practice the charge is compressed to pressures varying from 40 lbs. per sq. in. to 120 lbs. per sq. in. Suppose, therefore, that an average case is taken as an example and that the compression space for the problem in hand is to be 30% of the cylinder displacement; the charge will then be reduced in volume from that of the cylinder when the piston is at the extreme outward limit of its stroke to the volume of the compression space. During compression a small amount of heat is derived from the cylinder walls so that the curve does not follow the theoretical one, but is approximately of the form to be obtained from the following equation:

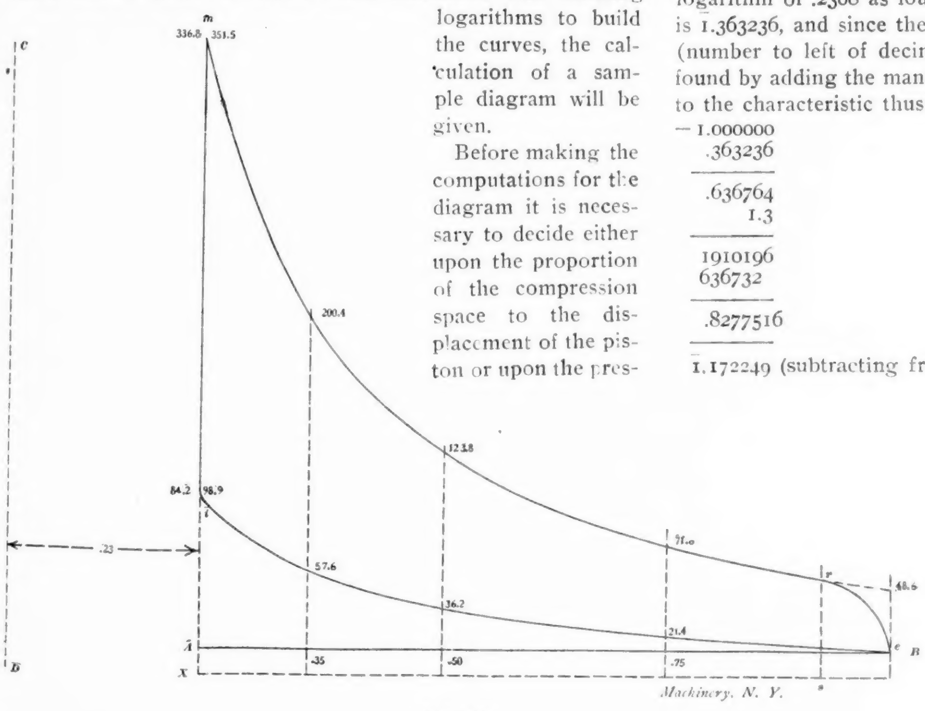


FIG. II

$$P V^{1.3} = K \quad (1)$$

Wherein P = the pressure above a vacuum or absolute pressure.

V = the volume of the gases at the time they are at the pressure P.

K = a constant.

For convenience, the volume of the cylinder when the piston is at the extremity of the outward stroke may be taken as unity and then the constant for the compression curve becomes the pressure of the atmosphere or 14.7. The pressure of the gases after explosion is, for natural gas, four times the pressure after compression. This gives the point of maximum pressure or the upper limit of the straight line. From the maximum pressure is derived the expansion curve which follows very closely that given by the equation

$$P V^{1.35} = C \quad (2)$$

Wherein P and V have the same significance as in equation (1) and C is a constant depending on the maximum pressure.

These equations may also be written as follows:

$$P V^{1.3} = P_1 V_1^{1.3} \text{ and } P V^{1.35} = P_1 V_1^{1.35}$$

This is perhaps a more convenient form to remember, as it shows the relation between any two points on the curves.

To begin the computation, the ratio of the compression space to the total cylinder volume must be found. The compression has been taken as .3 of the piston displacement and the total cylinder volume is the piston displacement plus the compression space or 1 + 3 = 1.3 times the piston displacement. The required ratio will then be $\frac{.3}{1.3} = .2308$ nearly. The total cylinder volume will be taken as unity and the compression space will then have a volume equal to .2308. To find the pressure at the end of the compression stroke apply formula (1) and the computation is as follows:

$$P V^{1.3} = K = 14.7 \text{ and } P = \frac{14.7}{V^{1.3}} = \frac{14.7}{(.2308)^{1.3}}$$

In order to find the denominator of this fraction it is necessary to multiply the true logarithm of the number by 1.3. The logarithm of .2308 as found in the table (the tabular logarithm) is $\bar{1}.363236$, and since the logarithm has a negative characteristic (number to left of decimal point), the true logarithm must be found by adding the mantissa (number to right of decimal point) to the characteristic thus:

$$
\begin{array}{r}
-1.000000 \\
.363236 \\
\hline
.636764 \\
1.3 \\
\hline
1910196 \\
636732 \\
\hline
.8277516 \\
\hline
\end{array}
$$

$\bar{1}.172249$ (subtracting from 1 000000 and adding − 1 to get the tabular log.).

Log. 147 = 1.167317 and subtracting the last found log we have that of the pressure at the end of the compression stroke thus:

$$
\begin{array}{r}
1.167317 \\
\bar{1}.172249 \\
\hline
\end{array}
$$

1.995068 = log of 98.87 = compression pressure in lb. per sq. in. above a vacuum. Call it 98.9, then the gauge pressure would be 98.9 — 1.47 = 84.2 lb. per sq. in.

To get the maximum pressure this amount is multiplied by 4 and the result is 84.2 × 4 = 336.8 lb. or 351.5 lb. absolute.

It is best to calculate at least three intermediate pressures in order to get sufficiently close to the proper shape of the curve. The pressures when the volumes of the gases are .35, .5 and .75 will usually give a sufficient number for the purpose. The corresponding pressures are found in the same manner as the compression pressure and are 57.6, 36.2 and 21.4 respectively, all being measured from vacuum. The pressures for the compression curve having been found, it remains to determine those for the expansion curve. Using formula (2) it is necessary to first find

the constant or the pressure when the volume is equal to 1. Hence $PV^{1.35} = C$ becomes $351.5\,(.2308)^{1.35} = C$.

Log. $(.2308)^{1.35} = 1.1404102$, found in the same manner as log. $(2308)^{1.3}$ above. Log. $351.5 = 2.545925$ and this log added to that of $(.2308)^{1.35}$ gives that of the constant, thus:

$$\begin{array}{r} \bar{1}.1404102 \\ 2.545925 \\ \hline \end{array}$$

$1.686335 = \log. 48.57 =$ the terminal pressure of the gases in case release takes place at the end of the stroke. And the equation of the expansion curve becomes $PV^{1.35} = 48.57$.

The intermediate pressures at the volumes .35, .5 and .75 are found from this equation in the same manner as for the compression curve, and they are 200.4, 123.8, 71.6. No attempt has been made to carry these figures beyond one decimal place.

The diagram is built up from these figures as shown in Fig. 11.* Vertical lines are drawn at distances from the line D C proportionate to the distances .23, .35, .5 and .75, the scale of the diagram being 5" = unit volume on the horizontal lines and 1" = 100 lb. on the vertical lines. In order to properly complete the diagram, the short curves at i and at r e should be added The curve at i represents that produced by the rise of pressure due to the ignition of the gases before the end of the compression stroke and it can be drawn approximately only, as it varies in size for any change in piston speed. Its effect upon the area of the diagram is so small as to make it of little moment save as a memorandum when comparing this diagram with those obtained from the engine itself. The curve r e is that due to release taking place in time to bring the point e where the expansion line meets the atmospheric line A B, at the end of the stroke. To construct this curve draw the vertical line r s at a distance from X m equal to .9 of the length of the diagram, in this case $.9 \times .77$ equal to .693 from X m. Through r draw a circular arc tangent to the expansion line and passing through the point e. Drawing curves through the points already determined and a straight line from i to m completes the diagram. The line X Y is the vacuum line and it is from X Y that all the pressures on the right of the vertical line are measured. In order to get the gauge pressures subtract 14.7 from the absolute pressures or measure from the atmospheric line A B.

The mean effective pressure may be found from this diagram in the usual manner by measuring its area with a planimeter and dividing this result by the length of the diagram. The area of the diagram is 3.272 sq. in., its length 3.85 in. and the area divided by the length is .85, and since the scale of pressures is 100 lbs. to 1 in. the M.E.P. is 85 lb. per sq. in. The diagram also serves as an index of what is taking place in the cylinder at any time during the cycle, and will in many instances save guess work on the part of the designer.

Taking this diagram as a basis of operations, suppose it is required to design an engine which will give 40 brake horse-power (B.H.P.) when using natural gas as a fuel. The mechanical efficiency of an engine of this size may safely be taken as 85%, hence the indicated horse power (I.H.P.) of the engine should be $40 \div .85 = 47.06$ say 47 I.H.P.

In order that the reader may fully understand every step of the process, and also be able to build up a formula of his own, should occasion require, the derivation of a specific formula from the general equation for I.H.P. will be given in its entirety. Both practice and theory have finally agreed that the best proportions for a four cycle gas engine cylinder are obtained when the stroke is made 1½ times the diameter of the cylinder. Practice seems also to indicate a limit of 600 ft. per minute for the speed of the piston. This, it is as well to note, is surpassed in some of the more modern vertical engines, but higher speeds than 600 ft. are unusual. The principal dimensions of the engine being based upon that of the diameter of the cylinder, it is most convenient to determine the diameter first.

The general equation for the I.H.P. of a gas engine is:

$$\text{I. H. P.} = \frac{\text{Plan}}{33{,}000} \quad (3)$$

In which P = M.E.P.
l = length of stroke in feet.
a = area of the cylinder in sq. in.
n = number of explosions per minute.

For convenience the following symbols will be employed throughout this series of articles :

D = diameter of the cylinder in inches.
L = length of stroke in inches.
R = revolutions per minute.

Since $L = 1\tfrac{1}{2}\,D$ and $l = \dfrac{L}{12}$, $l = \dfrac{D}{8}$

$$a = \frac{3.1416 D^2}{4}$$

The piston speed being 600 ft. $R = \dfrac{600}{2l} = \dfrac{600}{\frac{D}{4}}$. and since $n = \dfrac{R}{2}$,

$$n = \frac{600}{\frac{D}{2}} = \frac{1200}{D}.$$

By substituting these values in equation (3) it becomes:

$$\text{I. H. P.} = \frac{P \times \dfrac{D}{8} \times \dfrac{3.1416\,D^2}{4} \times \dfrac{1200}{D}}{33{,}000}$$

Simplifying this expression it becomes:

$$\text{I. H. P.} = .00357\,P\,D^2 \text{ and } D^2 = \frac{\text{I. H. P.}}{.00357\,P}, D = \sqrt{\frac{\text{I. H. P.}}{.00357\,P}} \quad (4)$$

For the engine under consideration this formula gives:

$$D = \sqrt{\frac{47}{.00357 \times 85}} = 12.45 \text{ say a } 12\tfrac{1}{2} \text{ inch cylinder.}$$

The length of the stroke is $3/2\ D = 18\tfrac{3}{4}$ in.

The revolutions per minute are $600 \div 3.125 = 1.88$ nearly.

These results show what the dimensions of the engine should be to give 40 B.H.P. when working to best advantage. To many gas engine designers these dimensions will appear small for a 40 B.H.P. engine, but the writer has seen an engine proportioned according to equation (4) do even better on the testing floor. For the smaller powers it is necessary to employ a mechanical efficiency of 80%.

The constant in equation (4) becomes .00407 for a piston speed of 700 ft. per minute, a speed that is sometimes adopted for vertical engines of large powers.

A very common basis for the design of gas engines is an M.E.P. of 70 lb. per sq. in. With such a basis the cylinder diameter of the engine just considered would be:

$$D = \sqrt{\frac{47}{.00357 \times 70}} = 13.7 + \text{ say } 13\tfrac{3}{4} \text{ in.}$$

The length of the stroke would be $3/2\ D = 20{,}62$ in., say $20\tfrac{3}{4}$ in.

The r.p.m. $600 \div 3.46 = 173$ r.p.m., say 175 r.p.m.

Suppose that instead of a four cycle engine it was a two cycle engine that was to be designed. Since these engines have an impulse, each revolution formula (4) would evidently become:

I. H.P. $= .00614 PD^2$ for an engine having a stroke $= 3/2$ D.

But as these engines are seldom built in large powers, this formula would give too high a piston speed. Even formula (4) gives a piston speed higher than is customary for engines under 40 B.H.P. The piston speed of small engines is always lower than it is for engines of large powers, because it gives the engine too high a rotative speed at the crankshaft. The relation between the horse-power of a gas engine and the r.p.m. of the crankshaft can be determined from the following empirical formulae which are based on the average practice of gas engine builders in the United States.

$$\text{For a four cycle engine, } R = \frac{350}{(H)^{.21}} \quad (5)$$

$$\text{For a two cycle engine, } R = \frac{405}{(H)^{.21}} \quad (6)$$

Wherein R = r.p.m. of the crankshaft.
H = the brake horse-power of the engine.

The following formulae for the B.H.P. of a gas engine will also be found a convenience in the calculation of the principal dimensions.

$$\text{For a four cycle engine, } H = \frac{D^2 \times L \times R}{19{,}000} \quad (7)$$

* The diagram as shown is slightly smaller than the true scale.

For a two cycle engine, $$H = \frac{D^2 \times L \times R}{10,000} \quad (8)$$

The symbols in these equations are the same as given elsewhere in this article. The formulae are deduced from the practice of American builders and represent, with a mechanical efficiency of 80%, a M.E.P. of 66 lb. per sq. in. and 63 lb. per sq. in. respectively. They give very safe figures for the dimensions of engines using gasoline or natural gas for fuel, but from the nature of the formulae there is no allowance for variation in compression.

The subject of compression pressures is one of the most important in the whole subject of gas engine design. The higher this pressure, the better the economy of the engine, but with increase of this pressure come serious difficulties and frequently unexpected ones. As the pressure of a gas is increased the temperature is raised and a temperature is reached at which the charge will take fire from the rise of temperature due to compression. This is especially true when the temperature of the cylinder walls is not kept down to a proper point and an excessive amount of heat is derived from that source. This leads to the subject of "back-firing" or premature ignition, an extremely annoying feature. In many cases, however, this trouble may be traced to other sources. Should there be a projection of any sort within the cylinder, which is very thin, it may become heated to a high temperature and act in the same manner as does an ignition tube, but with the difference that it is likely to, and usually does, ignite the charge before the proper time and quite frequently during the suction stroke. A still more prevalent cause of premature ignition is a deposit of carbon on some projection on the piston. The carbon will reach a high temperature and when it becomes so hot as to ignite the charge before the proper time, the trouble begins. It is to these deposits of carbon that much of the trouble is due in engines using high compression. The way to avoid them is first to make sure that there are so few projections as possible extending into the cylinder and that none whatever project from the piston. It is also important that the cylinder lubricant should be of such a nature that it will not deposit carbon. Bearing this feature in mind it at once becomes apparent that the igniter electrodes should be placed in the path of the entering gases and that the igniter plug should be so placed that heat may be conducted away from it as rapidly as possible. It is but lately that the gas engine builder has recognized the importance of jacketing the exhaust valve and it is time that he should see the importance of carrying off heat from projections into the cylinder. This matter is assuming more importance at present in view of the tendency to high compression pressures which is now disturbing the gas engine designer.

To return to the subject of dimensions and to the use of equations (5), (6), (7), (8) and (9), suppose that it is intended to design an engine of 10 B.H.P. and of the four cycle type. It is necessary to first determine the speed from equation (5):

$$R = \frac{350}{(10)^{.21}} = 216 \text{ r. p. m.}$$

The operation is as follows:

Log. 10 = 1.000000, log. $(10)^{.21}$ = .210000, log. 350 = 2.544068, 2.544068 — .210000 = 2.334068 = log. 215.8 or 216 for an even number. A more convenient figure than 216 would be 220 and the departure from that given by the equation is too small to be important. Adopting this figure for the r.p.m. of the crankshaft, the next step is the determination of the cylinder diameter from equation (7). The ratio of the length of the stroke to cylinder diameter will be taken as in the former problem L = 3/2 D and equation (7) becomes:

$$10 = \frac{3\,D^3 \times 220}{2 \times 19,000} \text{ and } D^3 = \frac{10 \times 2 \times 19,000}{3 \times 220},\ D = \sqrt[3]{575.86}$$

D = 8.32 nearly, call it 8⅜.

L = 3/2 D = 12 9-16, or as the required dimension has been exceeded in the diameter, 12½ in. will be sufficient for the stroke.

The principal dimensions of the engine will then be 8⅜ in. diameter by 12½ in. stroke, and the r.p.m. 220. Checking these figures by means of formula (7):

$$H = \frac{D^2 \times L. \times R}{19,000} = \frac{(8\tfrac{3}{8})^2 \times 12\tfrac{1}{2} \times 220}{19,000} = 10\ 15.$$

This check shows that the proportions of the engine are ample to give the required 10 B.H.P. on natural gas. For gasoline the B.H.P. obtainable would be about 10% higher or 11 B.H.P.

It has been the custom in the past for manufacturers to rate their engines at a horse-power equal to about two-thirds of what they would give on natural gas when working at their best. There are many arguments for and against this custom, and each side of the question has good points in its favor. With the exception of gasoline, the quality of gaseous fuel varies with the locality, a cubic foot of gas representing all the way from 1/12 horse-power hour down. If an engine is rated at 15 B.H.P. for natural gas, it may not give more than 10 B.H.P. on some qualities of city gas. Again, it is not thought expedient by many to run an engine at more than three explosions to one miss for its normal load or at ¾ of its power when working to its full capacity. This makes an allowance for overload, which is quite an important consideration. On the other hand, a gas engine gives better economy when operating at full load, and it is often advisable to so divide the power between two or more engines that those running may carry, as nearly as possible, their full load. The balance of opinion seems to be in favor of rating the engine sufficiently below its best operation to allow a reasonable margin for overload. Many makers fight shy of this question by insisting upon knowing just what the engine is to drive and to then recommend a suitable size. It is always a good argument to the average power user for an engine to give more than claimed for it by the maker. Any falling off, however, appears to these persons inexcusable no matter what the circumstances may be. It is, by all odds, the safest plan to rate an engine below what it is capable of and to make economy guarantees only on the basis of what the engine is to be used for.

The denominator of the fraction in equations (7) and (8) may be changed to suit the basis of an entire series of designs. Thus if it is found that a number of engines which have been built according to some fixed shop rule will give as this denominator 21,000, it is quite safe to assume that the dimensions of other sizes may be based upon a formula the numerator of which is the same as that in equation (7). Suppose that in a certain factory there has been built an engine having a cylinder diameter of 11½ in. and a stroke of 17 in. gave 20 B.H.P. when running at 185 r.p.m. Calling the required denominator X, the equation would stand

$$20 = \frac{(11\tfrac{1}{2})^2 \times 17 \times 185}{X},\ X = \frac{(11\tfrac{1}{2})^2 \times 17 \times 185}{20} = 20,800 \text{ nearly,}$$

and the equation for this set of engines becomes:

$$H = \frac{D^2 \times L \times R}{20,800}$$

In the design of two cycle engines, the ratio of the cylinder diameter to the stroke is quite frequently 1, and the stroke is seldom more than 1.25 times the cylinder diameter. If the former ratio is taken as the basis of computation of the principal dimensions, equation (8) may be simplified to

$$H = \frac{D^3 \times R}{10,000} \quad (8a)$$

For example, suppose it is required to find the diameter of the cylinder for a two cycle engine of 12 B.H.P. Using equation (6) to find the speed it becomes:

$$R = \frac{405}{(12)^{.21}}$$

Log. 12 = 1.079181, 1.079181 × .21 = .22662801.

Log. 405 = 2.607455 and subtracting from this the log just found

2.607455
.226628

2.380827 = log. 240 +

Using equation (8a)

$$12 = \frac{D^3 \times 240}{10,000},\ D = \sqrt[3]{\frac{12 \times 10,000}{240}} = \sqrt[3]{500} = 7\ 937, \text{ say 8 in.}$$

Then since the stroke is equal to the diameter of the cylinder the engine should be an 8 × 8, and the r.p.m. 240.

(*To be continued.*)

The first article of this series appeared in the November issue.

SHRINK AND PRESS FITS

DISCUSSION FROM BOTH THEORETICAL AND PRACTICAL STANDPOINTS.

HENRY HESS

A question that has troubled many a mechanic and designer is that of the proper allowance to be made between a pin and hub when these are to rely on their grip only for steady company.

To resort to the handbooks does not bring much light.

Kent f. i. on page 973 says, on Coleman Sellers' authority, that 30 to 35 tons were required to press a 4.015 axle into a 4 in. bore; but he says nothing as to the force that would be required to separate these parts, which is, after all, the thing that a designer would most like to know.

Another quotation of Kent's on page 973 from the "American Machinist," gives a rule for the pressure required to force the parts together as:

$P = 6\ D$ for perfectly true and smooth holes.

$P = (6 \text{ to } 9)\ D$ for untrue or rough holes where D = diam. in inches.

P = total pressure in tons required for assembling.

But here no clue is furnished as to the difference of diameter to be allowed and again no mention is made of the cohering force of the assembled parts.

On looking up other authorities I picked up first Weissbach-Reuleaux "Ingenieur" in German and on pp. 658 found

$$Q = 2\,\pi\, r\, l\, S_1\, f \ldots\ldots\ldots\ldots \quad (1)$$

$$\frac{S_2}{S_1} = \frac{1}{v} \text{ if } v = \frac{\left(1 + \frac{t}{r}\right)^2 - 1}{\left(1 + \frac{t}{r}\right)^2 + 1} \ldots\ldots\ldots \quad (2)$$

and a table to aid solution, which, however, is not quoted, as it is for the present immaterial.

Q = force required to force in the hub at the last moment.

l = length of hub.

r = radius of pin when compressed.

t = wall thickness of hub.

S_1 = compression stress on the pin.

S_2 = tensile stress in the hub.

f = co-efficient of friction; assumed to be 0.2 for the usual metals in a dry state.

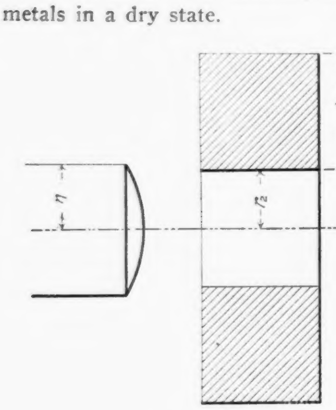


FIG. I.

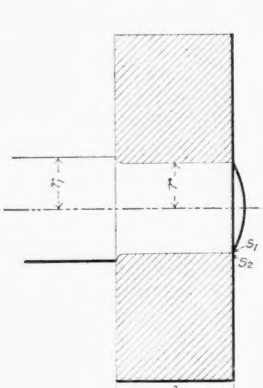


FIG. 2.

Now this begins to look as though there might be something in it—at any rate it takes into consideration the length of the hub, which certainly must affect the holding power. It is plain that if we have a narrow hub gripping a pin with a certain force, a second similar hub will grip with the same force and it will take twice as much pull to remove both hubs at once as it would to remove only one. The nature of the resistance to forcing on or off is undoubtedly frictional, somewhat complicated by a shearing or smoothing down of mechanical irregularities of the surfaces; this also is here taken into account by the introduction of the value "f". A little consideration will make it evident that the relation of pin to hub thickness will affect the results, since a relatively heavy hub can be made to grip tighter than a light one; the compressive grip must cause tension in the hub, of which a heavy one could stand more. But there is no clue as to the difference of initial pin and bore diameters that should be allowed.

Reference to my "steady company," Reuleaux's Constructeur, edition 1895, page 59 and after, gives what is needed for a complete solution.

Reuleaux approaches the problem somewhat differently in that he determines what original differences of size may exist between the pin and bore diameters without producing undue stresses in pin or hub. By the use of his expressions and those of Weissbach-Reuleaux an answer may be found to all the questions that either the mechanic or designer may wish to ask.

r_1 = original radius of the pin.

r_2 = original radius of the bore.

r = radius of pin and bore when assembled.

t = hub wall thickness.

l = length of hub.

S_1 = compressive stress at the pin surface, where it is greatest.

S_2 = tensile stress at the bore surface, where it is greatest.

E_1 = elastic modulus of the pin material.

E_2 = elastic modulus of the hub material.

Q = force required to force on the hub endwise when just getting home.

f = co-efficient of friction, etc.

P = proportion of pin and bore reduced to difference of radius of unit length.

$$P = \frac{r_1 - r_2}{r_2} \text{ (Reuleaux) } \ldots\ldots \quad 3.$$

$$S_1 = \frac{P\,E_1}{1 + \frac{E_1}{E_2 v}} \qquad S_2 = \frac{P\,E_2}{1 + \frac{E_2 v}{E_1}} \text{ Reuleaux 39).}$$

$$P = \frac{S_1}{E_1} + \frac{S_2}{E_2} = \frac{S_2}{E_2} + \frac{S_2 v}{E_1} \text{ (Reuleaux 38).}$$

$$v = \frac{\left(1 + \frac{t}{r}\right)^2 - 1}{\left(1 + \frac{t}{r}\right)^2 + 1} \text{ (Reuleaux 37)}$$

If $\frac{t}{r_2}$ =	0.5	0.6	0.7	0.8	1.0	1.5	2.0	3.0
then v =	0.385	0.438	0.486	0.528	0.600	0.724	0.800	0.882

Reuleaux uses the conditions when assembled; but for practical considerations, the original wall thickness and reamed (therefore standard and invariable) hole radius r_2 is more convenient and has the same practical effect.

These formulae may be accepted as correct for all stresses within the elastic limit, as they are based on the theory of stresses produced in circular elements under circumferential pressure, as worked out by Lame and others and universally accepted for guns, hydraulic cylinders, etc.

Provided now that the co-efficient resistance "f" is known, everything is ready for a solution. It is true that Weissbach-Reuleaux assigns to this the value 0.2 for the usual metals, but it is questionable whether this may be accepted as true in all cases.

In forcing a hub endwise on to a shaft undoubtedly the accidental irregularities that, in practice, are not entirely avoidable at a commercial cost of production, will be more or less smoothed down. It follows that the resistance to pulling off will be less than to forcing in. For a hub shrunk on this consideration falls out, and probably the same co-efficient will apply to pulling off as would apply to forcing on cold. Again the co-efficient or torsional grip will vary. It is quite probable that a hub forced in endwise will have a tighter hold against twisting, than one shrunk into place, because the forcing in may produce longitudinal grooves and elevations that will oppose twisting, while the irregularities raised by the turning tools are in the same direction as the twisting, and so do not oppose it.

Actual tests only can afford the data for determining the value of the co-efficient under various conditions. In the "American Machinist" of Feb. 16, '99, in an article on "Shrink and Force Fits," Prof. John J. Wilmore gives an account of some tests that will serve as a partial clue, and that when analyzed show the variations of the co-efficient under different conditions of assembling and separating.

In the following tables, columns 1, 2 and 3 are those given by Prof. Wilmore, while the others are calculated by the formula noted.

The key to the headings appears in the preceding page.

FORCE JOINTS SEPARATED ENDWISE.

Number of Specimens.		Q lbs.	P by Equation 3	S_1 by Equation 39.	S_2 by Equation 39.	f by Equation 1.
1	0.5005	1000	0.0010	8990	950	0.028
5	0.50075	2150	0.0015	13480	1420	0.040
10	0.501	2570	0.0020	17980	1900	0.036
14	0.50125	4000	0.0025	22480	2370	0.0036

SHRINK JOINTS SEPARATED ENDWISE.

Number of Specimens.	r_1.	Q, lbs.	P by Equation 3.	S_1 by Equation 39.	S_2 by Equation 39.	f by Equation 1.
2	0.5005	5320	0.0010	8990	950	0.150
3	0.5005	5820	0.0010	8990	950	0.160
11	0.501	7500	0.0020	17980	1900	0.110
12	0.501	8100	0.0020	17980	1900	0.160
15	0.50125	9340	0.0025	22480	2370	0.084
16	0.50125	9710	0.0025	22480	2370	0.087

FORCE JOINTS SEPARATED BY TWISTING.

Number of Specimens.	r_1.	Q, lbs.	P by Equation 3.	S_1 by Equation 39.	S_2 by Equation 39.	f by Equation 1.
6	0.50075	2200	0.0015	13480	1420	0.040
7	0.50075	2800	0.0015	13480	1420	0.053
13	0.501	4200	0.0020	17980	1900	0.060
17	0.50125	1465	0.0025	22480	2370	0.016

SHRINK JOINTS SEPARATED BY TWISTING.

Number of Specimens.	r_1.	Q, lbs.	P by Equation 3.	S_1 by Equation 39.	S^2 by Equation 39.	f by Equation 1.
4	0.5005	2200	0.0010	8990	950	0.060
9	0.50075	9800	0.0015	13480	1420	0.180
18	0.50125	13800	0.0025	22480	2370	0.116
19	0.50125	17000	0.0025	22480	2370	0.141

In all the specimens the hole is reamed to 1-inch and the length of hub is 1.25. The probable error of reaming is said not to exceed 0.00025; the probable error of sizing the pins is not known. The hubs were in the shape of flat cast iron discs 6″ dia., and 1-inch thick with a ¼″ projection on one side of 2″ dia. This projection is rather unfortunate as it introduces an element of uncertainty into the mathematical analysis. The projection has a well thickness of only ½″, while this disc has a wall thickness of 2½″; different stresses must be produced in these two portions of the disc and also in those portions of the pin they embrace. There must also be a zone of more or less extent over which these stresses tend to equalize. The pins were made of a good quality of machine steel. For the method of conducting the tests the article may be consulted.

Grip of Force Joints Separated Endwise.

The allowance per inch or radius varies from 1 to 2.5 thousandths of an inch.

The co-efficient of resistance as determined from the equations with the observed test results inserted varies between 0.028 and 0.0036; it increases with the increase of the forcing allowance. If the co-efficient were one of friction only there should be no such increase; it may therefore be accepted as due to the greater amount of reduction of inequalities or harder burnishing down of the surface.

A further increase of the forcing allowance is accompanied by a decrease of the grip co-efficient. This may be assigned to the increased compression stresses produced as shown under S_1, which are evidently too high; for No. 14 at any rate with $S_1 = 22{,}480$ it is very evidently too much.

Shrink Joints Separated Endwise.

The allowance per inch of radius varies from 1 to 2.5 thousandths of an inch.

Nos. 2, 3 and 12 show a fair correspondence of the co-efficient of resistance. The marked falling off of No. 11 may be due to some unnoticed defect of the surfaces or material. The marked effect of the increase of allowance in the co-efficient is noticeable until we get again in Nos. 15 and 16 too high compression stresses S_1 due to a large forcing allowance.

Force Joints Separated by Twisting.

Allowances as before.

Co-efficient of resistance increases with forcing allowance, up to that point where too great an allowance causes the compression stresses in the pin to go too high.

Shrink Joints Separated by Twisting.

Allowances as before. See notes immediately preceding.

Comparison of Force Joints Separated Endwise and by Twisting.

In both, the co-efficient of resistance increases with an increased difference between pin and bore, up to a certain point where the compression stresses become disadvantageously high. The resistance to separating by twisting is materially greater than to forcing off endwise.

Comparison of Shrink Joints Separated Endwise and by Twisting.

Tests do not show any material difference in value of coefficients of resistance at similar allowances of size differences, and are somewhat contradictory.

Comparison of Shrink with Force Joints.

Under similar conditions of separation the shrink joints possess a materially higher co-efficient of resistance.

The general tendency of the deductions regarding the relative qualitative values of the various methods of assembling as to the resulting resistances to separation appears reasonable and in accordance with abstract analysis. Before values may be assigned to the co-efficient of resistance further experiments on the most advantageous allowance for different diameters should be made. In conducting such experiments hubs of a uniform thickness with no disturbing excrescences should be used; the material entering into each pin and hub should be tested; if it were also tested after the experiment that would be of value, though not absolutely necessary. The tests should determine the elastic limits, the strength in comparison of the pin material and in tension of the hub material. A record should also be kept of the force required to assemble the joint, and this be noted at different points as an aid in determining the effect of length of hub; this will then also show the difference between the co-efficient of resistance in forcing on and off. With shrink joints care should be exercised to apply just enough heat for assembling.

One peculiarity shown by the tests cited is the low value of the co-efficient of resistance, which in only a few cases approaches the values commonly assigned to frictional resistances between dry metallic surfaces.

Such a series of tests would be decidedly appreciated by the engineering world, and be of more value to technical students than the ever-recurring pulling apart of pieces of iron in repetition of tests that have been made thousands of times.

* * *

In the report of the Bureau of Steam Engineering for 1899 is reference to the improvements that have been made in large steel forgings for the machinery during the past few years. The specifications for the Maine and Texas, which were drawn up in 1888 and 1889, respectively, required a tensile strength in this steel varying from 56,000 to 70,000 pounds per square inch, with an elongation of from 16 to 20 per cent. in two inches, both depending on where the test piece was taken; while the specifications for new vessels in 1898, just ten years later, require for high grade shaft forgings, nickel steel, oil tempered and annealed, a tensile strength of at least 95,000 pounds per square inch, an elastic limit of 65,000 pounds per square inch, with an elongation of 21 per cent. in two inches. All the shafting for several of the torpedo boats was made of this material, while in the battleships, monitors, and torpedo-boat destroyers, the crankshafts alone were made of nickel steel, simply annealed, with a tensile strength of 80,000 pounds per square inch, and an elastic limit of 45,000 pounds per square inch, with an elongation of 26 per cent. in two inches, the remainder of the shafting for these vessels being of the higher grade quality previously mentioned. The possibility of thus reducing machinery weight, without a sacrifice of endurance and strength is clearly obvious.

* * *

The quantity of steam that will escape from a boiler into the atmosphere through a small aperture is quite remarkable. An orifice of one square inch area will allow 98¾ pounds of steam per minute to escape from an initial pressure of 100 pounds gauge into the atmosphere. An aperture of only 1-100 of a square inch in area will allow an escape of nearly 60 pounds per hour under the pressures stated, so it is evident that small leaks are expensive luxuries.

Entered at the Post-Office in New York City as Second-class Mail Matter.

MACHINERY

A practical journal for Machinists and Engineers, and for all who are interested in Machinery,

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS,

9-15 MURRAY STREET, NEW YORK CITY.

ONE DOLLAR A YEAR, POSTAGE PREPAID, TEN CENTS A COPY.
FOREIGN SUBSCRIPTIONS ONE DOLLAR AND FIFTY CENTS A YEAR.

Lester G. French, Editor.
Fred E. Rogers, Associate Editor.

The receipt of a subscription is acknowledged by sending the current issue. Remittances should be made to The Industrial Press, and not to the Editors. Money enclosed in letters is at the risk of the sender. Changes of address must reach us by the 15th to take effect on the following month; give old address as well as new. Domestic trade is supplied by the American News Company or its branches.

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JANUARY, 1900.

CIRCULATION STATEMENT.

The regular edition of Machinery for January is 20,000 copies, American Machinery is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

The Iron Age, about	7,000
The American Machinist, about	12,000
Machinery	20,000

Owing to a strike among the engravers we were unable to send the data sheet with the December number, as usual, and it is mailed with this number instead. Those who have the September, 1899, data sheet will kindly note that in the second formula under "Centrifugal Force" the "w" is in pounds per cubic foot and that the third formula under this heading gives the number of revolutions per minute.

* * *

It seems to be the prevailing impression among European engineers that the present good times for American machinery builders will be even better after the opening of the Paris Exposition. The conditions throughout Europe at the present time are about the same as in Great Britain and in this country where there is an active demand for all the machinery that can be manufactured. The tendency of continental firms, however, is toward conservatism, and many of them feel disposed to wait before increasing their equipment until their engineers have had an opportunity to examine in person the products of American builders. This they will do during the exhibition. After this examination has been made and reports submitted, the various firms will be in a position to place orders intelligently and there cannot be much doubt that the machine tool builders of this country will obtain their share of the business.

Prof. F. R. Hutton, 12 West Thirty-first street, New York, is receiving subscriptions for the proposed memorial to Robert Fulton, the illustrious engineer who was so actively engaged in promoting steam navigation in the early years of this century. Fulton's remains were placed in the graveyard of Trinity Church, New York, where they have remained neglected and forgotten for over three-quarters of a century. At the Washington meeting of the American Society of Mechanical Engineers, action was taken toward erecting a suitable monument to his memory. The undertaking is in the hands of a committee of this society and no contribution need be considered too small to be sent for the purpose of perpetuating the memory of Fulton's life and work. In fact, it would be more suitable to have the monument erected through the aggregate of a large number of small contributions rather than as the result of a few large ones.

* * *

THE RIGHTS OF ADVERTISERS.

If a newspaper publisher insisted that an advertiser should pay him a specified sum for an unknown amount of space, how much business would he get? Yet most publishers insist that an advertiser shall pay for an unknown amount of circulation when circulation is vastly more important than space, for without circulation space is valueless.

We contend that an advertiser has the right to know just what he gets from a newspaper for his money; the same knowledge he exacts when he buys coal, or steel, or oil. Would he contract to pay his oil manufacturer a number of hundred dollars a year and leave it to the latter to say how much oil should be supplied for the money? Would he run any other department of his business as some publishers want him to run his advertising department?

It is to the interest of all advertisers to insist on a circulation statement as a part of their contract, and when it is refused they should refuse their business. It is to the interest of all legitimate trade papers to encourage advertisers to exact this information, and thus shut out a mass of schemes and worthless mediums which prey upon manufacturers and absorb a large proportion of their advertising expenditure.

An advertiser who buys space in Machinery has only to look on the editorial page every month to know what he gets for his money. He is entitled to this information, and every newspaper he spends money in should give it to him—without asking.

* * *

BOOK REVIEWS.

It is common practice for publishers to send copies of their new books to the different periodicals that circulate among readers interested in the subjects covered by these books. In acknowledgment of this courtesy, it is expected that a review will be given in the reading columns of the periodicals and thus information relative to the books will be widely circulated.

It is also the common practice of many of these periodicals to give a favorable notice of every book that is received, partly, perhaps, because the publishers of the papers are themselves interested in the sale of books and every favorable review will have a tendency to increase the business of their book departments. On the other hand, it is the policy of some other publications to present a critical review of each book as it appears, in which it is felt that the knowledge of the reviewer is sufficiently displayed, and all the requirements of an impartial review answered, if a few sentences are picked out here and there and pulled to pieces, and various other adverse comments made at random upon different sections of the work.

It is obvious that in the first instance the readers of the periodical are not receiving the consideration they have reason to expect at the hands of a publisher or an editor, whom they patronize regularly as subscribers. Many of them wish to add to their libraries of reference from time to time and in the long run there will be a reaction, and those who have been misguided will no longer have confidence in the paper they formerly relied upon. In the second instance, the position taken by the reviewer is unjustifiable from any standpoint. He does not benefit the reader, the publisher or the author and does the latter a positive injustice. No one can produce a book without defects, and as any two authorities will differ, the fact that a reviewer may differ

from an author should make the former careful that he is not influenced too strongly by his own personal preferences.

It is fair to say that in a book review the same critical judgment should be employed that one would use in deciding upon the merits of a machine. A book requires as much labor and careful thought as a complicated machine, and it often takes longer to produce it.

Suppose, for example, that a person desired an engine lathe and sought for information at the hands of one who had actually seen and examined the particular lathe that it was intended to buy. He would want to know, first, about the design and workmanship upon the essential parts of the lathe, and, secondly, whether the person who examined it detected any weak points that would materially detract from the lathe for regular shop work. Instead of getting this information, if he were told that one of the cap-screws in the carriage had been battered by the workman in putting the parts together, that the paint was too light a shade of gray, that the feeds were reversed in the headstock instead of in the carriage, while he, the one who had made the examination, personally preferred to have the reversal in the carriage, and much other irrevelant information, what sort of an idea would be formed of the worth of the lathe? If it were found that the cap-screws were battered throughout, that the feeds lacked power and that the castings were rough and poorly painted, it might be presumed that other parts of the machine were slighted also. Adverse criticism, however, would not be made if the important parts as a whole came within the bounds of good practice for the purpose intended, even if their design did not meet entirely with the personal preferences of the critic.

In like manner, the only fair way, either to an author, a publisher or the reader of a paper, is to consider a book in its entirety in relation to the purpose for which it was designed. A reader wishes to know, first of all, what a book contains, what ground it covers and what its scope and limitations are. Then, if there are any weak points, like serious omissions or sections that are in error or for other reason would be likely to mislead, he should be told about these. This latter should be done, however, by picking out essentials and not non-essentials.

It is but fair to add, on the part of the reviewer, that it is not always possible to give a book critical study either from lack of time or lack of technical qualifications. No one man can become an expert in all branches, and it is now universally admitted that a man does well to reach the top in one. In any case, however, the aim should be to give as impartial an estimate of the book as time and qualifications will admit, and if there are unfavorable comments the author must remember that if a book contains errors that can be readily detected by a superficial examination, or even a single totally wrong treatment of a fundamental principle, the reviewer may easily obtain the impression that the subject is not well treated.

* * *

A recent consular report from Great Britain states on the authority of an interview with a well-informed machinist that the improvements in machine tools and the benefits resulting from their adoption in that country, have been tremendous within the last three or four years. No machine shop can now be well equipped without tools from the United States—lathes, shaping machines, planing machines, screwing machines, etc. These, not to attempt to enumerate the hundred kinds of hand tools, are being used everywhere throughout the British Islands. You may say that no machine shop worth mentioning in this country is without at least such tools as turret lathes and ordinary lathes of American manufacture. The turret lathe, which is made in many sizes, varying in price from $250 to $1,000, is a typical example of the general convenience of American tools. With the ordinary British lathes, used for the same purposes, workmen lose time in substituting one tool for another which may not be readily found. The turret lathe obviates this delay. A full assortment of tools being fixed in its turret, the workmen can instantly get any tool by a slight turn of the turret. Certain British manufacturers are now turning out machine tools, etc., made exactly, or almost exactly, after American designs. A firm in Leeds makes a specialty of constructing machine tools and some other labor-saving machinery according to American patterns. This company probably pays a considerable sum in royalties to American patentees.

EQUATIONS.

An equation is generally defined as an expression of equality between two or more quantities. To many, however, it may seem to be a clearer explanation to show how an equation can be derived from a simple proportion in arithmetic. For example, we know that the areas of two circles are to each other as the squares of their diameters. If one circle is 4 inches in diameter and its area is 12.566 square inches, what is the area of a 5-inch circle? Calling for the time being the area of a 5-inch circle x, we have, by the principle just stated,

$$12.566 : x :: 4^2 : 5^2 \text{ or}$$
$$12.566 : x :: 16 : 25.$$

Now, this expression will have just the same meaning if we draw a line between the first two dots and the last pair of dots, making signs of division of them, and then connect the two upper and the two lower pairs of dots that belong to the middle group, by straight horizontal lines, making a sign of equality. The expression will then be as follows:

$$12.566 \div x = 16 \div 25.$$

This is an equation and it is read, "12.566 divided by x equals 16 divided by 25." It may also be written $\frac{12.566}{x} = \frac{16}{25}$, the fractions indicating division without the sign of division. This equation is solved by multiplying 12.566 by 25 and dividing by 16, just as the proportion given at first would be solved by multiplying the 12.566 by 25 and dividing by 16; that is, by multiplying the two extremes together and dividing by the known mean, giving the same result and requiring the same operations as in the case of the proportion. The great stumbling block with equations is that it is not always clear how to solve them and determine the quantity desired. With proportion it is easier to do this, but proportion does not have the flexibility nor the adaptability of the equation and it is the main object of the science of algebra to show how to use the equation and how to apply it.

* * *

COLLEGE DEGREES.

A change in the system of giving degrees in engineering is now being considered by the Armour Institute of Technology, of Chicago, and Prof. C. V. Kerr, Chairman of the Committee on Degrees, is sending out a circular of inquiry to obtain the opinions of engineers on this subject. From this it appears that the institute is now giving the graduates from the four years' course in engineering the degree of Bachelor of Science (B. S.) in mechanical, electrical or civil engineering, as the course may indicate. A number of engineering schools do the same and give the full engineering degree after two or three years' practice, while other engineering schools give the degree (C. E., M. E. or E. E.) on graduation. Two of the questions propounded in the circular are as follows:

(1) Should the engineering degree be considered as merely an academic degree like the B. A., or should it be considered a professional degree like M. D.?

It seems to us that it should be considered as an academic degree, since no amount of purely academic work can make a man an engineer. It is educational and preparatory work, fitting the student for the practical work of his future career. To give a graduate a degree of C. E., etc., is meaningless from a professional point of view. The M. D. degree is a little different, for while these initials added to the name of a newly fledged graduate cannot make him an experienced or efficient doctor, yet their use by unauthorized persons is prohibited by law. Therefore they have some actual meaning, however limited, whereas there is nothing to prevent anybody, graduate or not, from styling himself C. E.

(2) If we consider the engineering degree as professional or descriptive, like the M. D., and merely indicating the nature of the student's intended career, is it proper to grant the engineering degree, M. E., C. E. or E. E., at the end of a strong four years' course?

Under the conditions stated, it might be proper to do this, though it would undoubtedly be better even then to decide that the degree should only be given after practical experience. As we have above stated, however, it does not appear to us that engineering degrees should be considered as "professional." It may be well to point out, in conclusion, that nothing is gained by the profession, the college, or the graduate, by granting degrees too early or too cheaply.—"Engineering News."

A MODEL DRAFTING ROOM.

AN EFFICIENT AND CONVENIENT ARRANGEMENT EMBODYING NOVEL FEATURES.

X. Y.

There are still to be found shop managers who fail to appreciate the fact that it is cheaper to make mistakes on paper than in construction; who do their work on the cut and try plan of fitting each piece to its fellows as the work progresses, of necessity rejecting many pieces that fail to come right.

Fortunately the species is fast becoming extinct and the unalterable law of the "survival of the fittest" will soon drive them out of business or into more modern lines.

More numerous, however, are the type who, while admitting the necessity of drawings, look upon them as a necessary evil instead of in their true light of a valuable money-saving device.

What wonder that our manager, after a few months' experience with such an outfit, is more than ever inclined to think that the drawing office, drawings and draftsmen, are a piece of tom-foolery, "only fit for those who are so bound up in red-tape that they can't tell Bill to bore a couple of gears for Smith without writing it all out on a card with a red number, a space for weight of the castings, time of the boring, etc.; just as though Bill couldn't tell the book-keeper all about that," provided either of them happened to think of it.

This type, fortunately, is rapidly giving place to the kind of management which organized the drafting department it is our purpose to describe.

Fig. 1 is a floor plan of the drafting room which occupies the entire floor. In one corner is the private office of the mechanical engineer, chief draftsman or whoever is the responsible head of the department. This room has two doors, as

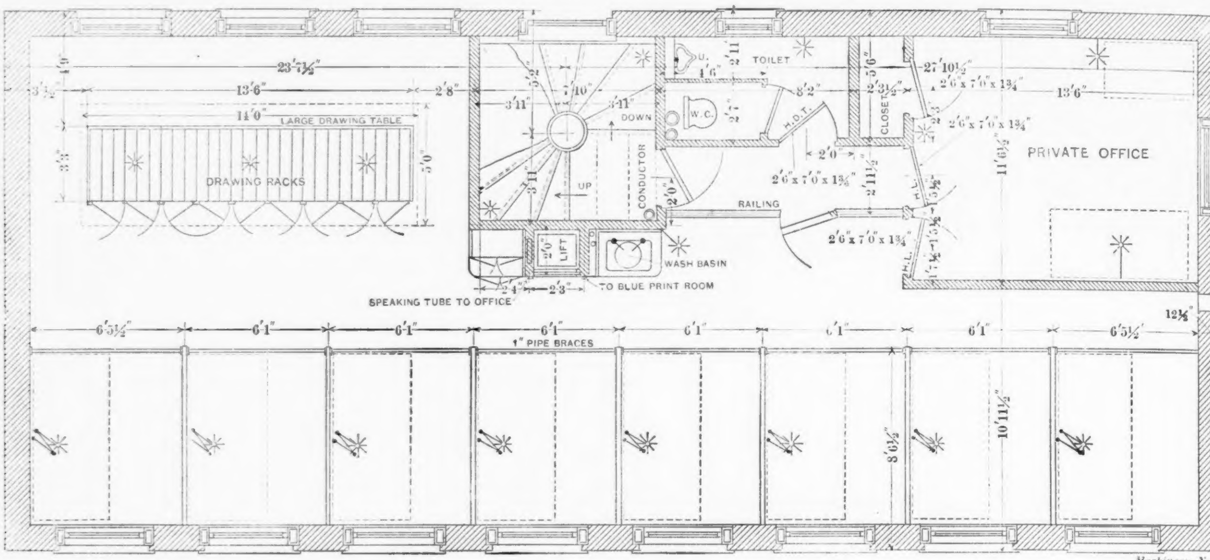


FIG. 1. FLOOR PLAN OF THE DRAFTING ROOM.

In many establishments, the drafting room is a little 7x9 affair with a couple of rickety horses and an apology for a board, and therein is installed the draftsman. Some one has said that the primary qualifications of a draftsman are accuracy, clearness and rapidity, but with the above-mentioned type of manager, there is another qualification which far outweighs any or all of these, namely: a willingness to work cheap. With such, work cheap and cheap work are synonymous.

Note the situation. A room hot in summer, cold in winter, poorly lighted and ventilated, with the most meager appliances

FIG. 2. ONE OF THE PRIVATE COMPARTMENTS.

and presided over by the cheapest man that can be found who has assurance enough to style himself a draftsman. What can be expected from such a combination? Would it not be surprising to find anything but poor design and erroneous dimensions emanating from such a place?

shown, one of which opens directly into the drafting room, the other into a passage separated from the drafting room by a railing, and leading to the stairway. On the other side of this passage are the toilet rooms, while the central part of this side of the building is occupied by the winding stairway lead-

FIG. 3. GENERAL VIEW OF ROOM

ing to the floor below and to the blue-print room on the roof. The remainder of this side of the floor is occupied by the large drawing table, of which more later.

The entire west side of the room is divided into compartments, or stalls, as the boys call them, by partitions 7′ high and extending about 8′ 6″ from the wall. This gives to each man a separate compartment 8′ 6″ x 6′ 1″ and isolates him, in a measure, from his fellows, obviating, to a large degree, the liability of having his attention distracted by the movements of the others. In each compartment is a table 3′ 6″ x 8′ 0″, supported

at the inner or left-hand end, by two legs and having a cabinet under the other for storage of reference books, sketches, unfinished drawings, etc., while in front at the center is a drawer with lock and key, fitted with tills for drawings, tools, pencils, tacks, colors, brushes and all articles in more less constant use. Each compartment has a window with a shade which draws

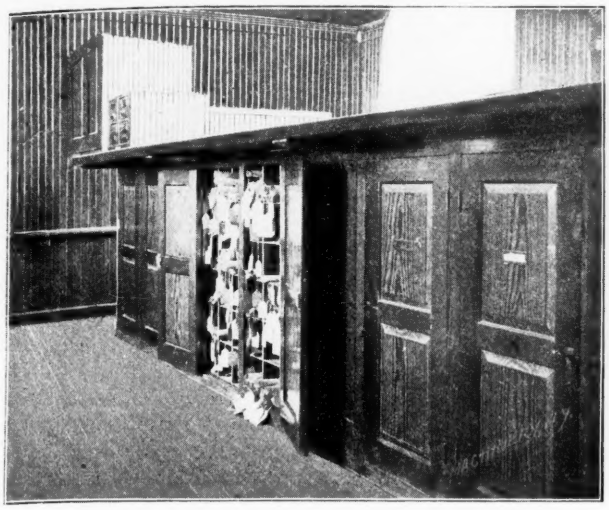


FIG. 4. LARGE DRAWING TABLE WITH PIGEON HOLES AND FILES.

up from the bottom, and an incandescent electric light on a swinging bracket attached to the partition over the center of the table.

Fig. 2 is a photograph of one of these compartments. It will be seen that each man has ample room to work and a convenient place to keep everything in the way of data, un-

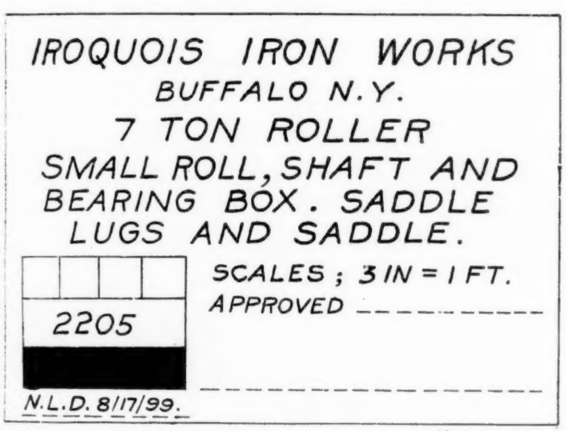


FIG. 5. STANDARD TITLE.

finished drawings, and all the things incident to his work, without allowing them to lie around in sight and in the way. This makes it possible to keep the room clean with a minimum of labor and greatly facilitates the work, while being, at the same time, conducive to neatness and accuracy.

In each compartment is an electric buzzer, seen to left of the window in Fig. 2, which is connected by a push button with the desk of the mechanical engineer and also with that of the manager on the floor below, while a speaking tube alongside the dumb waiter affords means of communication with either. In calling a man, his button is pushed in conformity with the Morse code corresponding to his initial, with an additional signal which calls him to the speaking tube or to the desk of the mechanical engineer or manager.

Fig. 3 is a view taken from the door of the private office and, in connection with Fig. 1, gives a good idea of the general appearance of the room. The large drawing table which occupies the space on the east side of the room beyond the stairway is more properly a case for the filing of drawings and tracings. Fig. 4 shows its construction. The front is divided into compartments, lettered from A to I, inclusive, and each compartment into 18 pigeon-holes for the reception of drawings which are rolled and placed therein.

The Standard Title, Fig. 5, is placed in the lower right-hand corner of the drawing, and the same corner is folded over for about half an inch, and an eyelet inserted for the attachment of the filing tag, Fig. 6. The small square in the lower left-hand corner of the standard title is divided into three parts. The middle one is for the drawing number, the lower one is black, showing white on blue print, for the insertion of a blue print number, while the upper one is divided into small squares for the insertion of re-issue letters. In the original drawing these re-issue squares are blank. Should alterations be made, the letter B is inserted in the left-hand square, while a note, with date, is added calling attention to the alteration. Subsequent alterations are denoted by insertion of C. D, E, etc., with appropriate notes always dated.

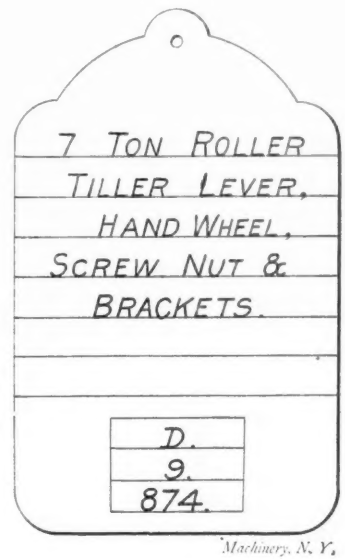


FIG. 6. FILING TAG.

The filing tag, Fig. 6, is ruled on both sides with horizontal lines for the title of the drawing, as shown, while the small square at the bottom is divided into three parts for compartment letter, pigeon-hole number and drawing number respectively.

D.	Ten Ton Roller.	
1	Crank Shaft, Connecting Rod.	R. E. G.
923	Eccentric Rods and Strap.	....
....	Eccentric Sleeve and Traveller	1-17-95
....	....	....
....	....	....
....	....	....

FIG. 7. FILING CARD. (ORIGINAL ABOUT 3 X 5 INCHES.)

On top of filing case, Fig. 4, may be seen a globe card case with four drawers, which is used as a card catalogue of the drawings. Two drawers are used for consecutive numbers, while the other two are divided by index cards into groups corresponding to the various machines manufactured. This gives two cards for each drawing on file, making it easy to find a drawing if either its number or title be known.

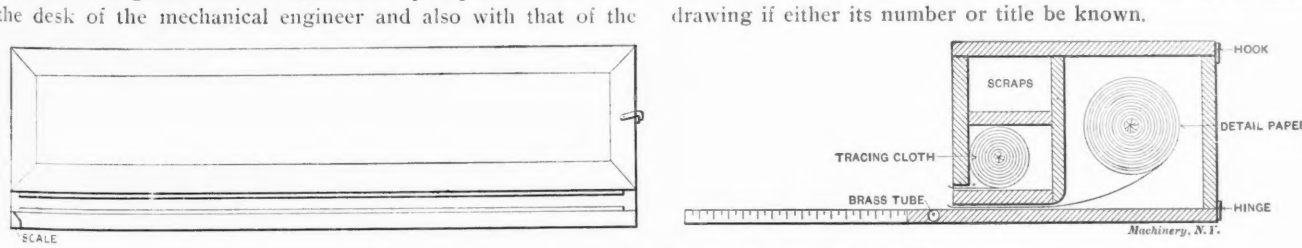


FIG. 8. DETAILS OF BOX FOR PAPER AND TRACING CLOTH.

The cards, Fig. 7, are filled out with the compartment letter, pigeon-hole number and drawing number in the left-hand margin. The top line of the body of the card contains the name of the machine to which the drawing belongs, while below are full details as to what part or parts are shown on that sheet. In the right-hand margin are the initials of the draftsman an-

date. On top of the drawing case, behind the card catalogue, can be seen the top of a case for detail paper, tracing cloth, etc. This is shown in detail by an outline drawing, Fig. 8, and forms a very convenient receptacle for these articles, keeping them clean and in good condition. When either paper or cloth are wanted, all that is necessary is to catch hold of the edge and draw out the requisite distance, as indicated by the attached scale, and cut off by inserting the point of a knife in the slot in the tube.

We are aware that there is, perhaps, nothing in use here that is new or original, but the point which we wish to emphasize is the effort on the part of the management to keep posted on what others are doing and to adapt whatever is good in their methods to our use. They realize fully that the drafting department may be either a source of great expense with very inadequate returns or the most profitable department in the works, all depending on the ability of the men employed and the facilities afforded them for their work.

A single bright idea evolved in the drafting room and put into practical operation may in a single year effect a saving more than equal to the entire cost of maintenance of the department. But no man will or can do his best work where the surroundings are not conducive to bodily comfort. No bright ideas in machine design or constructive details need be expected from men suffering from excessive heat or cold, nor from men whose attention is constantly being distracted by the movements of others. Hence, the careful attention to proper heating and ventilation, the scrupulous cleanliness and the isolated arrangement adopted.

Such surroundings naturally attract and hold the best men, and it is an axiom that in all departments of mechanical work the best man is the cheapest in point of output. It will be found in every case that the money expended in such facilities is well invested.

As before said, we lay no claim to originality in the above and doubt not there are many drafting departments far in advance of this, and if this sketch has the effect of calling forth criticism or a description of more satisfactory arrangements or methods we will consider our time well spent.

* * *

RECENT DEVELOPMENTS IN THE HALIFAX (ENG.) DISTRICT.

James Vose.

The tool-building trade of Halifax and district, Yorkshire, has within the last few years entered upon a new phase of activity, and bids fair to furnish a very appreciable share of Great Britain's present and future output of high class machine tools. Though any amount of the low-priced tools, for the production of which Yorkshire has for many years been widely known, may, on demand, still be obtained in Halifax, quite a number of Yorkshire tool builders have definitely determined to lay themselves out for the production, on modern lines, of substantial and well finished tools. In fact, one of the representatives of a well-known firm handling the higher grade of English and American tools recently informed me that, in his opinion, a larger percentage of really high class machine tools is being laid down in the Yorkshire tool-making centers than in the Manchester district. One result of the present prosperity in the engineering trade, as a Halifax manufacturer remarks, is that people have ceased quibling about a few dollars in the price of a machine, and now, from quarters where a year or two ago a matter of five or six dollars would have turned the scale in favor of the lower-priced article, it is quite common to receive inquiries for tools with machine cut gearing, and to have the increased price paid without demur. Messrs. J. Butler & Co. have from January, 1899, supplied cut gears on their tools at the same prices as formerly charged for cast gear. A special gear-cutting department equipped with the latest machinery helps to make this departure possible. In addition to gear-cutting machinery several heavy American milling machines are in use, also planers, shapers, and drills. In this connection it is noted by the firm in common with others I have spoken with, and which my own experience confirms, that however admirable American cast-iron may be for purposes of rapid machining, it does not show to great advantage as regards durability in comparison with English cast-iron when used for working surfaces. For instance, the sliding surfaces of an American planer satisfactory in other respects, were found to wear so rapidly, that a month or two after starting up, it was necessary to take out the rack, and plane the back of it, as the platen was riding on the pinion more than on the bed. This operation has since been repeated. In a case under my own observation, the teeth of the rack pinion of an American shaper were worn more in five or six months than those of an English machine of the same stroke and doing the same work, in as many years. It is a fact not yet grasped by many American makers, that the English metal imposes a much more severe test on the durability of machine tools than does the American. On the other hand, it would probably pay English manufacturers to look more closely into the matter of obtaining metal adapted for rapid tooling in cases where wearing properties are not particularly in question. Messrs. Butler are the makers of a varied line of tools, and though fully aware of the advantages of specialization, they, like many other British firms, will "make haste slowly" in that direction, as there are many solid indirect advantages in being prepared to give a customer just what he requires. Messrs. C. Redman & Sons, a concern managed by several brothers of a progressive bent, could give points to many much more pretentious shops. Practically all their gearing is machine cut, and no expense has been spared in obtaining good tools for their own use. The gear cutting department has come in for careful study, Brown & Sharpe machines being the most used. The effort to obtain maximum production in regular runs of work, such as lathe change wheels, has introduced several interesting problems in machine-tool designing which I have no doubt Messrs. Redman will solve satisfactorily. One American lathe obtained by the firm beat the record for bad design and construction. It was hopeless to attempt to improve it, and in the course of a few weeks was disposed of for a nominal sum. It is a pity this class of tool ever leaves its original obscurity.

This works is all on one floor, with the exception of the pattern shop and drawing office which work in conjunction under the same management. This arrangement works very satisfactorily. The pattern department being some distance from the main shop, its shafting is electrically driven. A specialty of this firm is planing machines, arranged, as a rule, to run at 20 ft. cutting, and 80 ft. return speeds. Another of their lines is a lathe containing a number of American features, including the inverted vee bed apron, etc., but retaining several characteristics of English practice. I have not seen this lathe at work, but can testify to the easy and satisfactory working of the planers. A feature of the last two or three years is the number of works started on a small scale, but fitted up in the best style for the manufacture of milling cutters, reamers, etc. Messrs. R. E. Hattersley & Co. represent this tendency in Halifax and are turning out some good specialties in the way of expanding reamers, and special small tools to customers' requirements. It is worth noting that the goods of this class of manufacture are being sold in competition with and in several cases by the same agents as leading American lines.

At the works of the Campbell Gas Engine Co., Halifax, is a very good collection of modern tools, including examples of English, Scotch, American and Swedish machines. In consequence of increasing business, a considerable extension of the productive facilities has become imperative and is being rapidly carried out on well-considered lines.

The substantial character of every description of building in Halifax is a noticeable feature of the town and district. Most of the buildings are of stone, to the comparative exclusion of brick, and this substantiality may be taken as typical of Yorkshire, its inhabitants and industries generally. In the future keener competition in supplying the world's material needs, this quality will probably stand its possessors in good stead, being conducive to the acquirement of a desirable equipment for most contests, that is, staying power.

* * *

Tests on aluminum wire, recently made at the Massachusetts Institute of Technology, showed an ultimate strength of 26,000 to 27,000 pounds per square inch and an elastic limit of 12,000 to 18,000 pounds. It is probable that aluminum, not in the form of wire, would be considerably weaker, owing to the fact that wire, which is made very dense in the process of manufacture, is always stronger than larger bars of the same material.

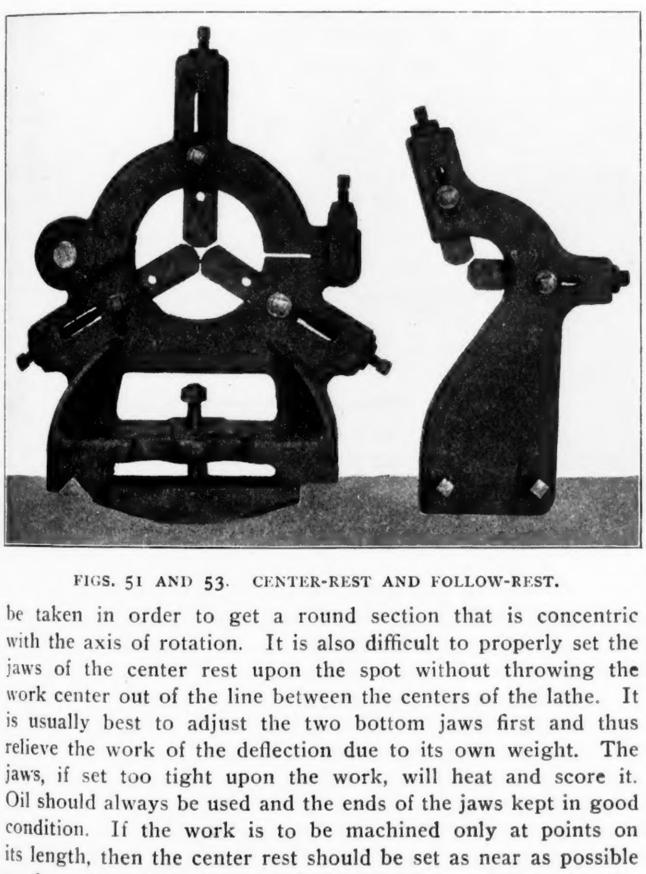
MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—6.

TURNING LONG WORK AND OFFSET TURNING.

W. H. Van Dervoort.

In article No. 3 the method for turning a plain spindle held between centers was taken up somewhat in detail. When the spindle is very long and its diameter relatively small, it becomes necessary to support it at some intermediate point or to provide some form of support immediately back of the cutting tool, as otherwise it would, owing to its own weight and the pressure against the cut, spring excessively causing it to chatter and leave an untrue surface. In such a case, the cut would have to be very light to prevent the work from bending or climbing up on the point of the tool, which is a very exasperating accident that frequently happens even when the greatest care is exercised, and it usually results in spoiling the work.

The center or steady rest in its general form is shown in Fig. 51. Its construction is plainly seen from the figure. The foot is clamped to the shears of the lathe at any convenient point and the three sliding jaws are so secured that they can be adjusted upon a portion of the work's length that has previously been turned true and smooth. If the bar is to be turned over its entire length, this spot is usually taken just off the middle point and a little closer to the live center than the dead one. This enables the operator to turn from the dead center toward and somewhat past the middle. The work can then be reversed, the jaws adjusted to the turned portion and the balance of the spindle machined. Truing the spot is usually slow, as light cuts must



FIGS. 51 AND 53. CENTER-REST AND FOLLOW-REST.

be taken in order to get a round section that is concentric with the axis of rotation. It is also difficult to properly set the jaws of the center rest upon the spot without throwing the work center out of the line between the centers of the lathe. It is usually best to adjust the two bottom jaws first and thus relieve the work of the deflection due to its own weight. The jaws, if set too tight upon the work, will heat and score it. Oil should always be used and the ends of the jaws kept in good condition. If the work is to be machined only at points on its length, then the center rest should be set as near as possible to the point where the work is being done, and thus give the greatest amount of rigidity.

Frequently it becomes necessary to steady a bar for turning that is not and cannot be made round at the point where the center rest is to be applied. In such cases the device shown in Fig. 52 and commonly known as a cat head may be used. It is simply a collar turned round on its outer surface and provided with suitable set screws for centering it up on the work. This gives a round bearing which, as before, is made to run within the jaws of the center rest. The cat head must be so adjusted that it runs perfectly true on the outside or otherwise the work will not run true when the head is removed after turning. The effect of crowding the work with one of the jaws out of its true axis of rotation is to turn the work tapering. Thus, if the work is crowded by the center rest toward the tool, it will be turned smaller in the center than at the ends and in like manner larger at the center if crowded away from the tool. Vertical motion does not affect the diameter to so great an extent, since, if the tool is set at the height of the center, the work can be raised or depressed quite a distance without making much change in the diameter. If, however, the tool sets above or below the center, a material taper will be given to the work. For example, if the tool sets above the center and the work is depressed at the center rest, it will be turned larger in diameter at the rest than at the dead center. Very often it is desirable to support the work right at the tool for the entire length of the cut. This is accomplished by using the follow rest, an example of which is shown in Fig. 53. It is quite similar in its most general form to the center rest, having two jaws, one behind and the other on top of the work. It is secured direct to the carriage and consequently moves with the tool. If the

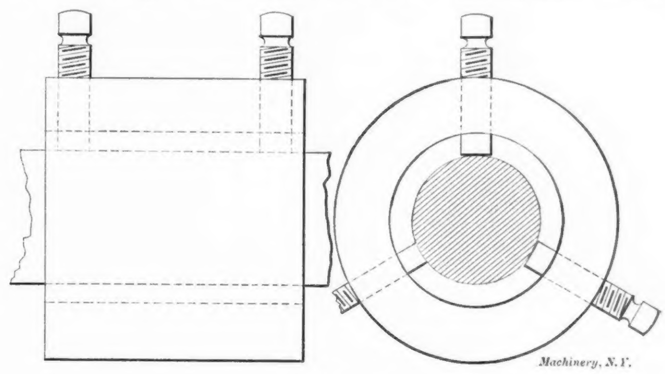


Fig. 52

work is in the rough, the rest follows after the tool, but if it has been previously trued, the rest may be set ahead of the tool. It is, however, usually preferable to have the rest follow rather than lead the cutting tool. For work of small diameter a single jaw with a V-end serves well.

The producing of satisfactory results in the use of the follow rest requires good judgment on the part of the operator. It should be set as soon as possible after the cut has left the dead center and while the work is rigid and true. Any irregularities in the work surface on which the follow rest passes serve to reproduce these same irregularities throughout the length of the work, and it is, therefore, very important to start exactly right. In the cutting of threads on long light rods the follow rest is indispensable. It is also of value in steadying work that is being operated upon by a cutting-off tool. It is superior to the center rest for this purpose, inasmuch as it can be set so much closer to the point where the cut is being taken.

An example of center rest work is shown in Fig. 54. Here, as is frequently the case, it is required to operate on the end of the work which precludes the possibility of running that end on the center. The center rest carries the outer end, the tail stock is moved back out of the way and the carriage is given ample room to get the tool at the work surface. The work must be firmly secured to the head spindle. When a center bearing can be had in that end of the work, it is best to carry it on the live center. This requires some method for clamping it to the face plate to prevent it from drawing off the center. When the work has a convenient shoulder near the outer end, the inner faces of the jaws of the center rest may be made to bear against the shoulder and thus prevent the work from drawing away from the live center. A collar can be clamped on the work to accomplish this result, but this method is not satisfactory except, perhaps, in the case of very light work, as the center rest is not rigid against a side pressure and the cramp of the dog or driver is quite certain to crowd the work off the center. A clamp, as shown in Fig. 55, slipped over the work behind the dog and drawn, by means of the bolts, firmly against the face plate will be found quite satisfactory. It is necessary that the clamp be drawn up squarely, as otherwise the truth of the work, especially if light, will be effected.

In cases where there is no center bearing in the live center end of the work, and one cannot conveniently be arranged for, that end can be carried in a chuck. If the chuck is an inde-

pendent one, the work must be very carefully centered in it. If a universal chuck is used and exact centering of the work is required, it is equally necessary to test the truth of the work, as universal chucks, after being somewhat worn, lose their accuracy for exact centering. The work should be caught close to the ends of the jaws, except in cases where the jaws and surface of the work gripped are known to be absolutely true; otherwise the outer end of the work will be thrown out of the center of rotation and, if brought back by the center rest, a spring in the length of the work must result. It is, in any case, difficult to set the center rest so that it will hold the axis of the work exactly coincident with the line of the centers. If not so held, the work will run true but all cuts will be tapering. If it is much out in this adjustment, it will cause the live center end of the piece being machined to work on the centers or in the chuck jaws, the usual result being the loss of the grip. The stiffer the work, the more noticeable this action.

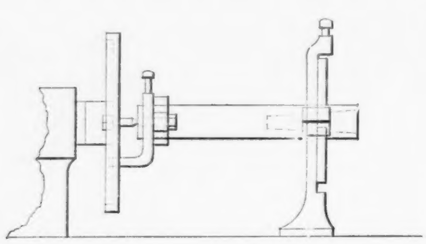


Fig. 54

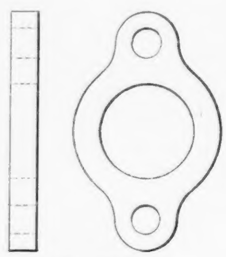


Fig. 55

The turning of external tapers can be accomplished in several different ways. As above indicated, in center rest work if the rest holds the end of the work so that its center is back or ahead of the line of centers, tapered work results. In like manner where the work is carried on both centers, if the dead center is moved across the bed, the center line of the work will be at an angle with the direction of motion of the carriage and tool, and tapered work results. As all engine lathes are provided with a set-over adjustment in the tail stock, this method of turning tapers is always available. As the amount of side adjustment is limited to a small range, only slight tapers can be produced in this manner, and especially so in cases where the work is long. Thus, if the tail center can be set over one inch and the work is four feet long, then, as shown in Fig. 56, it will be turned two inches smaller at the dead center end than at the live center end, which would give a taper of one-half inch per foot. If the work was one foot long, as shown by the dotted lines, it would have a taper of two inches per foot. The above indicates the method for determining the amount to set the tail center over to produce any taper per foot within the limits of the adjustment. Thus, if the work is eighteen inches long and a taper of five-eighths of an inch per foot is required, at one foot the off-set would be one-half the required taper or five-sixteenths of an inch, and at one and one-half feet it would be $1\frac{1}{2}$ x 5-16, or 15-32 of an inch. This is, of course, only an approximate method for determining the proper amount of set-over as the exact amount must, in nearly every case, be found by trial. It will, however, serve better than a guess for the first trial. The principal objection to this method of taper turning is that the centers of the lathe no longer point toward each other, and the center bearings in the work do not, therefore, bear properly upon them. This frequently causes excessive wear on the bearings and sometimes throws the work out of true. The ends of the work must be faced off perfectly square or otherwise the work will be sure to run somewhat out when held on off-set centers. Since in this class of turning, the work does not stand at right angles to the face plate, it is necessary to allow for some in-and-out motion for the arm of the dog or driver through the face plate. When the lathe is provided with a taper attachment, as shown in Fig. 8, article 1, external tapers may be turned without off-setting the dead center. This leaves the true bearings on the centers and does not necessitate the difficulty of having to adjust the dead center for parallel turning each time a taper job has been done. Taper attachments are given a much wider range than can be obtained by offsetting the center and are equally as useful in boring tapered holes or in turning external tapers.

In all taper attachments the mechanism is such as to operate the tool rest direct from a guide set at any required angle within its limits, with the shears of the lathe and independent of the cross-feed screw, yet at the same time retaining the in-and-out adjustment of the cross-feed screw. As several parts and consequent joints are required in such combinations, a considerable amount of back lash usually exists. The effect of this back lash is to let the tool start on a parallel cut until the back lash is taken up when it starts off on the required taper. This, although annoying, can usually be overcome by carrying the tool enough beyond the end of the work to allow the slack to take up by the time the tool is brought up to the cut. It will be understood that it is not necessary to let the feed bring the tool up to the cut, as it can be advanced quickly by hand, the only point being to carry it far enough to take up the slack by the time the tool reaches the work. On work of small diameter where the tool strikes the side of the center if moved beyond the end of the work, the back lash can generally be taken up by pulling out or pushing sharply in on the tool post, depending on the direction of taper the attachment is set to turn. Thus, if it is set to turn an increasing taper from the dead center toward the live, the angle of the guide will be such that its end nearest the head stock will be the closest to the shears and the inside face of the block will be forcing the tool back from the center of rotation. It would then be necessary in taking up the back lash at the beginning of the cut to push the tool toward the center. The maximum range usually given the taper attachment is four inches per foot.

It is seldom necessary to turn or bore steeper tapers than can be bored with the taper attachment. When, however, such are required, a lathe with a compound rest can be used. Examples of the compound rest are shown in Figs. 3, 8 and 10, Article 1. Its construction is such as to allow the upper slide which carries the tool to be set and secured at any angular position with the cross slide, thus enabling the turning or boring of any taper. Although the range is small, steep tapers are usually short and it is consequently seldom that the tool must be reset in turning any ordinary taper. What is commonly known as offset turning

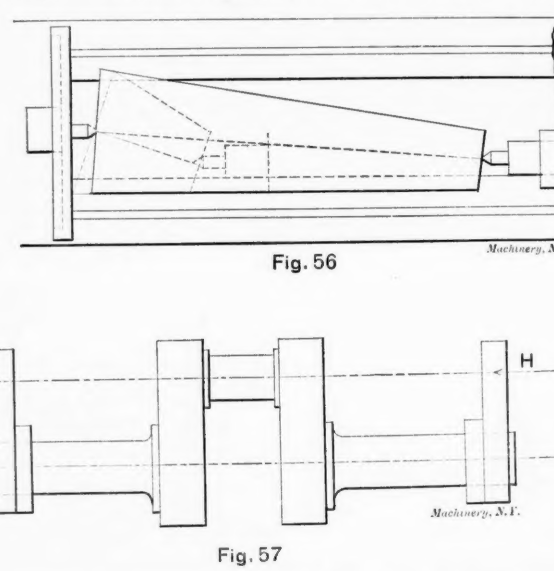


Fig. 56

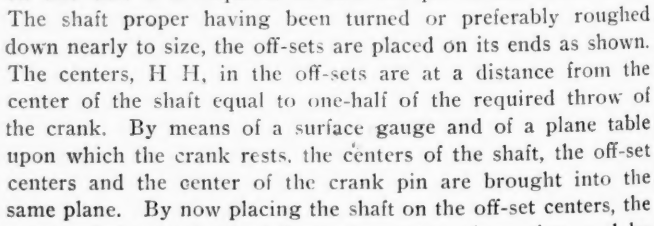


Fig. 57

between centers is illustrated by the example shown in Fig. 57. In this case it is required to turn the pin of the crank shaft. The shaft proper having been turned or preferably roughed down nearly to size, the off-sets are placed on its ends as shown. The centers, H H, in the off-sets are at a distance from the center of the shaft equal to one-half of the required throw of the crank. By means of a surface gauge and of a plane table upon which the crank rests, the centers of the shaft, the off-set centers and the center of the crank pin are brought into the same plane. By now placing the shaft on the off-set centers, the center of the crank pin falls in the center of rotation, and by means of a long tool that will reach the pin through the throat of the crank, it is readily turned. A sufficient counter weight should be placed on the face plate opposite the shaft to balance it and thus make the lathe rotation smooth. As it is not possible to use a center rest on work of this kind, and as danger of

springing the shaft is great, considerable care must be exercised in turning the pin. In turning the shaft, a center rest can be used. It is usual to place a block firmly in the throat opposite the ends of the shaft to prevent springing the arms together. The finishing cut should be a light one taken with the block removed and the centers very lightly adjusted, thus insuring a true running shaft when complete. Eccentric turning comes under exactly the same head. The center of the eccentric, however, usually comes inside the bore and the off-set centers can therefore be placed in the mandrel itself.

* * *

An employe of the Pennsylvania Railroad is reported to have invented a mechanical stoker for locomotives which is destined to "displace several hundred thousand firemen and allow locomotives to be run by one man instead of two." It is stated that "by merely turning a little wheel an engineer can feed coal into the firebox at the rate of 21 cubic feet per second." With the gradually increasing size of locomotives, it is probable that either mechanical stokers or two firemen instead of one will be the rule, but railroad companies will have to furnish free accident policies to their patrons if they expect them to ride behind locomotives having a crew of only one, as this inventor would lead us to expect.

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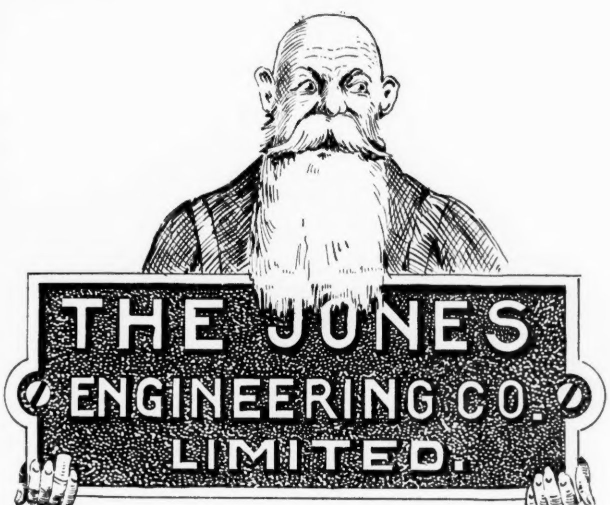


CHAPTER 5.—A COMEDY OF ERRORS.

Jones always had a lot of boys around his shop, not that he was fond of boy help, but he found it difficult in the country to get men to do boy's work. "The great army of the unemployed" has its camp in every large city, but not even a picket line stretches out to Jonesboro. Now these lads were about as playful as a cage full of monkeys and Jones was often bothered to keep them in check. One morning, among the misfortunes which never come singly, was a broken belt, and Jones roared and bellowed for those boys, like an old-time sea captain. "Here, you Dick, and you Charley, lay aloft there and lace that belt, and be spry about it, too." Jones' idea of economy was to buy a side of leather and cut off a strip for a lacing whenever it was needed, and those kids carved that hide into all sorts of fantastic shapes in getting out enough leather to lace one small belt. Then they played "hollowe'en," throwing the lacings over their heads to see if they would take on the shape of any letters when they struck the floor. They played they were firemen, turning out to a fire and they put a ladder up and both ran up the ladder with the agility of monkeys. In this manner the lacing was accomplished and the job was reported done. The "old man" was not at all pleased with it, however. "Here, you, haven't I told you whenever you laced a belt to keep the lacing straight on the inside and cross on the outside of the belt? Now, I've got to take that all out and lace it over again and I want you to see how I do it. Hold that ladder for me." Still grumbling away he mounted the ladder and slowly picked out the offending lacing and laced it over as a "sampler" for the boys. Then he climbed down and directed them to pick up the tools and put away the ladder, but the ladder could not be removed. Jones had laced it in! The boys exchanged nods and winks, which Jones happened to see. "You, Dick, what are you winking about?"

"Wasn't winking, sir; my face slipped."

"Well, see that it doesn't happen again. It's a good deal as the poet says:

'One boy is a boy,
Two boys half a boy,
Three boys no boy at all.' "

What did Jones say about the belt? Well, what could he say? He was spared the necessity of saying anything, for just

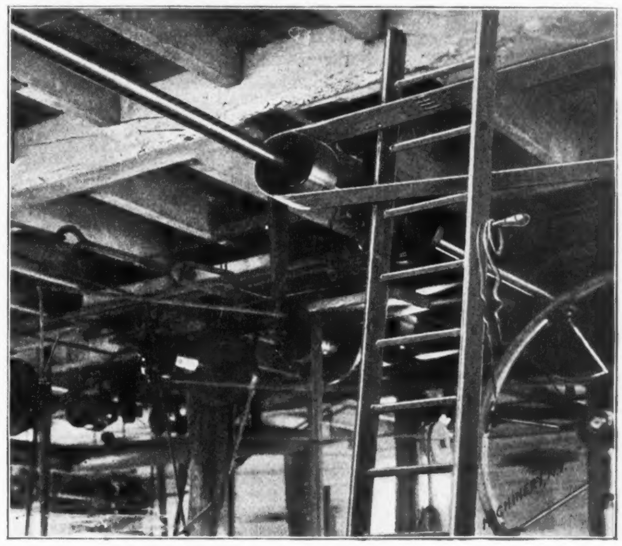


FIG. I. A SAMPLE OF BELT LACING.

then in walked a man with his arms full of patterns and his pockets bulging with drawings, and the "old man" was only too glad to entertain him. He wanted a machine built, but, as he asked Jones to keep the nature of it a secret, I will not betray his privacy; however, I will tell you some of the incidents of his visit. He prided himself on the excellent proportions of his design, and asked Jones if he had ever done anything in that line.

"No," said Jones, "hain't got no proportional dividers."

"Proportional dividers?" asked the stranger.

"Yes," Jones answered. "Them kind that you can set to any sort of a machine that you happen to be getting up and get the proportions of the different parts. Don't have to do no guess work at all, if you are getting up a lathe; jest set them for a lathe and they'll give ye the right proportions of the spindle and the bed and the legs, at least that's the way I understand it."

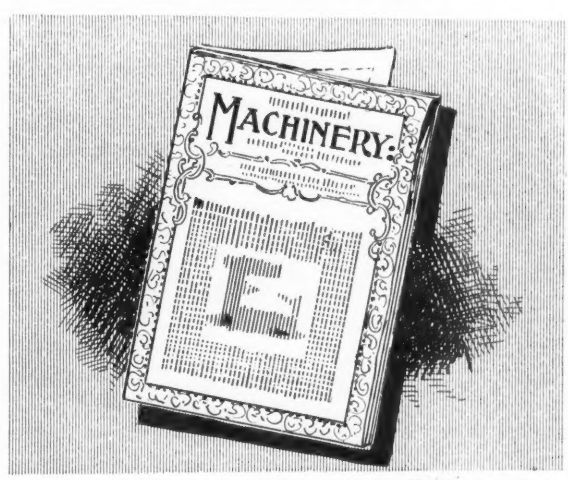


FIG. 2. "HIS NAME WAS MAC HINERY."

"Ah, indeed! Must be a great convenience," said the stranger "Now I get most of my ideas of proportion from this," opening a copy of MACHINERY.

"Looks like a good thing," Jones replied. "Do they get a new one each year?"

"Every month," said the stranger, and reaching for a piece of paper he jotted down the name and address of the periodical

and handed it to Jones. His machine proved to be easily understood excepting one point. He had detailed a sort of lifting jack which was designed to raise the point C 1¾ inches, as illustrated in Fig. 3. Jones understood the movement well enough, but he argued that, as the short arm A of the bell-crank was only 1½ inches long and moved from a horizontal to an upright position or through 90 degrees, the lift could only be equal to the length of this throw, or 1½ inches, and he could not understand where the additional one-quarter inch was gained.

"The link B," said the inventor, "is the hypothenuse of the triangle when in its normal position, and is one-quarter of an inch longer than the altitude."

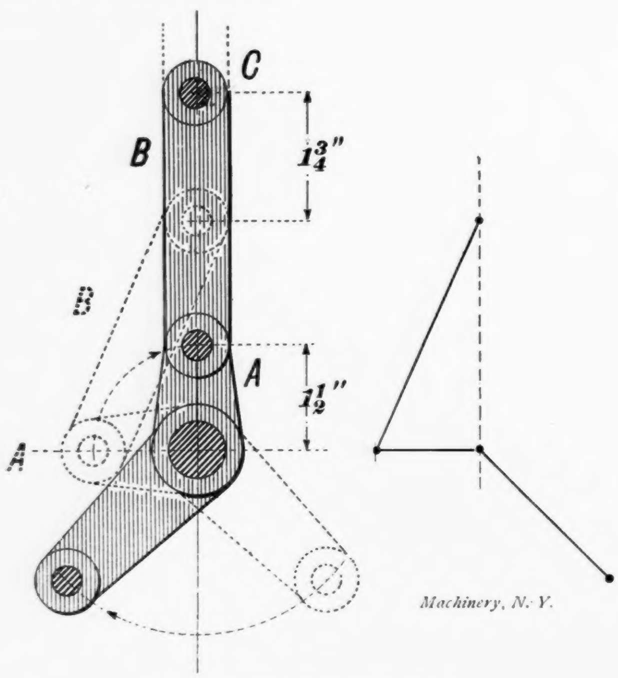


FIG. 3. THE "HIPPOTIMUSE."

"Don't know nothing about hippotimuse. All I know is, we'll build yer jimcrack jest accordin' to yer draft, and if it lifts an inch and three-quarters, well and good, and if it don't lift but an inch and a half, don't say I didn't give yer fair warnin'."

"Very well, Mr. Jones, if you work according to my drawing that's all I ask. Good day."

"Dad, who was that?" asked young Jones.

"He give me his address right here," said the old man, looking at the slip of paper which his visitor left. "His name is MACHINERY, 9 to 15 Murray street, New York."

"Less see that paper. Why, dad, that ain't his name; that's the address of that paper he was a showin' you."

"Gosh! so 'tis, sonny." W. H. S.

* * *

BALL BEARING REQUIREMENTS.

In considering the general question of requirements for a ball bearing that is to sustain such a load as is commonly met with in machines, we find that we must have balls of uniform size and each of uniform diameter; something which is now attained to within $\frac{1}{10000}$ of an inch. To insure rolling contact without rubbing of balls, and to distribute wear, it is often necessary to confine the balls in cages. To avoid slipping, a bearing surface of the same radius of curvature as the ball cannot be used. The bearing surface on which the balls roll should be hardened and ground to perfect truth. Large enough balls and a large enough number of balls should be used to carry the load without danger of breaking.

This last qualification looks to be easy of attainment, but is really an uncertain factor in the design, for two balls apparently exactly alike, as far as making is concerned, will vary considerably in strength. As the failure of one ball will generally ruin the entire bearing, uniformity of strength is therefore a requisite.

If, as the tests indicate, the average breaking load for a one-inch ball be about 80,000 pounds, and these balls will flatten at about 7,500 pounds pressure, the rule of loading balls to one-fifth of their breaking capacity is far from being even approximate. If held directly between two parallel surfaces less than a tenth of their breaking load would be a nearer approximate for safety and durability. If, however, the ball rolled in V grooves so as to have four points of contact, then a higher load could be carried safely. The surface resistance of a small ball of ¼ or ½ inch diameter is probably as great as that of an inch ball, in which case it might safely carry the same load as the large one if this were within its elastic limit. This matter should be carefully investigated, but from what is already known it would seem that the safe load for a ball should not be based on its breaking load, but on that load within its elastic limit which will mark its surface when in contact with a hardened flat plate, as described above.—Alton L. Smith, in "Journal of Worcester Polytechnic Institute."

* * *

WORTH HEEDING.

At the annual meeting of the National Railroad Master Blacksmiths' Association words of wisdom were spoken that will bear repeating. In the course of an address Mr. J. M. Barr said: "I always have trouble when I want to pick out a man to take charge of other men. I do not know where I can find a man that will fill the bill. I think that men in charge of work ought always to look for the man that shows some ability and give him an opportunity to show what he can do. Give him a 'shove.' I do not care whether he is in your shops or not; if you have a good man help him when you can. Do not, because you have a good man, hold him there at small pay, but give him a position in some good shop and he will be ready to come back to you when you want him."

Mr. R. Quayle, superintendent of the M. P. C. & N. W. Ry., said: "The point I want to make is that men you have about you are intelligent and thoughtful; they know a good thing when they see it and they appreciate a good foreman when they have one, and are not nearly so much inclined to take advantage of a foreman who treats them kindly when he is absent as they are the man who is harsh and abusive and stands over them with a club. The old homely saying that you can catch more flies with molasses than with vinegar is also true with men. If you want the best out of me don't abuse me, but appeal to me as a man, and if it is in me I will measure up to your requirements. Is not the same thing true of you, and if it is true of you is it not true of any man in your employ? This is one of the various means for getting the largest possible returns for money expended."

* * *

SHOP TERMS ILLUSTRATED.

BOILER JOINT.

LETTERS UPON PRACTICAL SUBJECTS.

TESTING ENGINE LATHES.

Editor MACHINERY:

In my article on the testing and adjusting of engines lathes, which appeared in the October number of MACHINERY, it was not intended to go into the many methods used for this purpose, but simply to give a few of the most simple examples. It was also intended to take up each alignment separately. This latter point, "Nemo," in his criticism in the November issue, evidently lost sight of, since in testing the carriage cross-shears for right angles to the spindle it was assumed that, as by the preceding paragraph, the spindle was parallel with the shears on the bed.

If after facing the plate, it should be plane when tested with the straight edge, the spindle and cross-shear must be at right angles with each other as stated. If it does not bore a straight hole an entirely different alignment must be considered, as we would find the rather unusual condition of spindle not parallel with shear and cross-shear out by exactly the same angular amount.

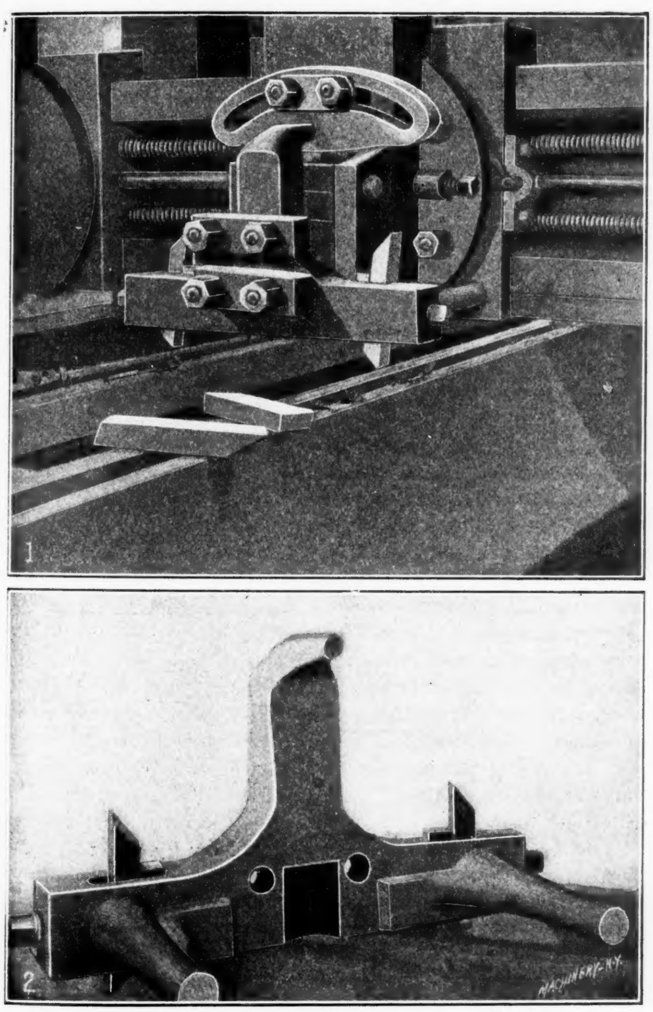
W. H. VAN DERVOORT.

* * *

TOOL HOLDER FOR PLANER.

Editor MACHINERY:

The tool shown in the accompanying half-tones, Figs. 1 and 2, and sketch, Fig. 3, is a duplex roughing tool holder, designed principally for roughing off the top and shears of lathe beds. It is designed to be used only where the heads on the cross-rail cannot be brought close enough together. The tool consists of a cast iron head with two arms, one on each side extending out about 8″, two legs at the extreme end of each arm which extend back and bear on the planer saddle. This forms a very rigid support for the tools. The head is clamped on the tool box in the same way as on any other tool, only the two lower studs come through the head. The nose at the top of the tool extends back within a ¼″ of the apron swing, acting as a stop.



FIGS. 1 AND 2. TOOL HOLDER FOR PLANER.

As the planer reverses, the apron cannot rise too high and cause the tools to catch or bind, as the nose or stop will prevent the apron from rising above a certain point.

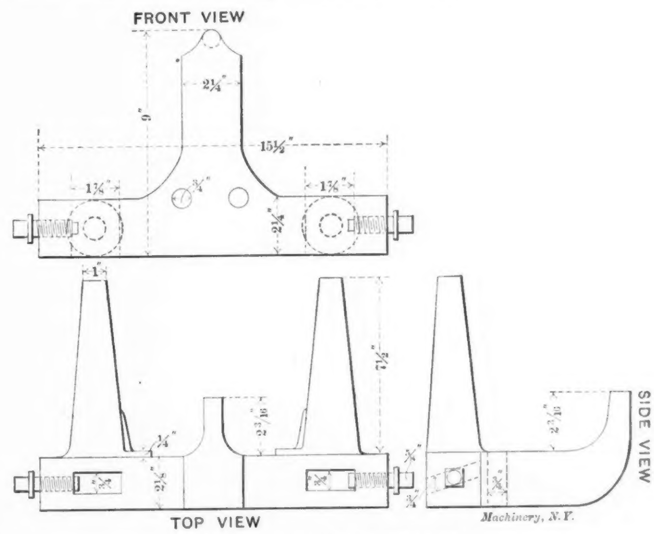


FIG 3 DETAILS OF HOLDER.

There are two slots, one in each end of the arms, ¾″ wide by 2″ long. These are to receive ¾″ square self-hardening steel. The slots are made 2″ in length, so that the tools can be adjusted for different size lathe beds, by placing a gib on either side of the tools. The tools are held in position by two ⅜″ screws, one at each end of the arms. There are two pads, one on each side of the apron. When the apron is down these pads bear on the tool box, while the legs bear on the saddle. The results obtained from the use of this tool are very satisfactory, and it can be used single or double and will stand a good heavy cut.

HENRY J. NOTZ.

Hamilton, Ohio.

* * *

INSERTED CUTTER LATHE TOOLS.

Editor MACHINERY:

It has been many years since inserted cutter tools were invented to take the place of tools forged to shape, but for some reason they are not used as much as their merits seem to justify. During all this time these cutter tools have been in the market and available to users, but although I have worked in many shops and visited many others, I have never seen any such tools in practical use, except a few home-made affairs, mainly of poor design or construction. I have sometimes discovered such tools on the tool board, but always without any cutters, and I doubt if any of them had been supplied with a second cutter after the first one was used up.

The old-time forged tool has two features which may never be equaled by any cutter tool. First, it is stronger, more rigid and can be used in a smaller space than is possible with the cutter tool. Second, it will conduct the heat away from the cutting edge more effectively. If heavy and rapid cutting is to be done, or if the tool must work in a limited space, it is unpractical to use the inserted tool. Much the greater part of the work done by machine tools, however, is finishing and shaping surfaces that have but a limited amount of stock to be removed, and for this work the cutter tool is superior in several ways.

The systematic method, developed by Sellers, of making standard forged tools is, of course, the right way to make them if enough are used to justify the high cost of grinding machinery, but that is certain to prevent the use of the system in a large majority of shops. In medium size and smaller shops and particularly in job and repair shops, the cutter tools are the most useful and certainly deserve a fair trial.

The value of forged tools depends much on the skill of the tool dresser and few such shops have blacksmiths who are good tool makers. Forged tools have so much surface to grind when

sharpening, that to save time they are often badly ground and hence are inefficient. The cutter tools usually have either the rake or the clearance fixed by the position of the cutter, so that the sharpening is done by grinding all on one or two faces, which is a saving of time and steel, besides making it much easier to keep the tool the right shape. There is also an advantage in having cutters of uniform temper throughout, produced by an expert, who, perhaps, does nothing else, so that no matter how much is ground away in sharpening, it does not reach a soft part. Then consider the time saved when the cutter is worn out, by being able to insert a new one in a few minutes, instead of loafing in the blacksmith shop a half hour waiting for the tool to be dressed. Owing to the small section of the cutters, the best quality of steel may be used without excessive expense.

For using on a lathe, these tools have the advantage of keeping the cutting edge the same height above the bottom of the holder, so that when changing from one tool to another very little, if any, adjustment of height is required. For cutting threads it is simply a foolish waste of time to grind forged tools to fit a thread gauge by the cut-and-try method, and such tools should never be used unless a special grinder is used for producing correct angles, because inserted cutter thread tools may be bought that are excellent in design and are easily sharpened by grinding on top without changing the angle. Such threading tools will save their cost by the economy of time in grinding and give, in addition, the great satisfaction of doing accurate and rapid cutting.

There are at least seven different makes of cut-off tools in the market and about as many other kinds, and certainly some of them must be in extended use, for they have been in the market for a number of years.

About all the advantages seem to be in favor of the inserted cutter tools, especially for small shops, and I would like to know why they are not in more general use.

If they have serious faults, will some of the people who have used them come forward and tell us just what is wrong with them and give, if possible, the reason why more of them are not in use? I do not remember ever having seen a record of any experience or opinions about such tools in the mechanical papers, but if they are a good thing I do not see why they should not be discussed and their merits made more familiar to machinists, for I am sure cutting tools are of a great deal more importance than many of the subjects that fill the pages of mechanical papers every year.

If there is no response to this I will take it for granted that such tools are faultless and that there is therefore no excuse for any shop to be without a suitable supply of them.

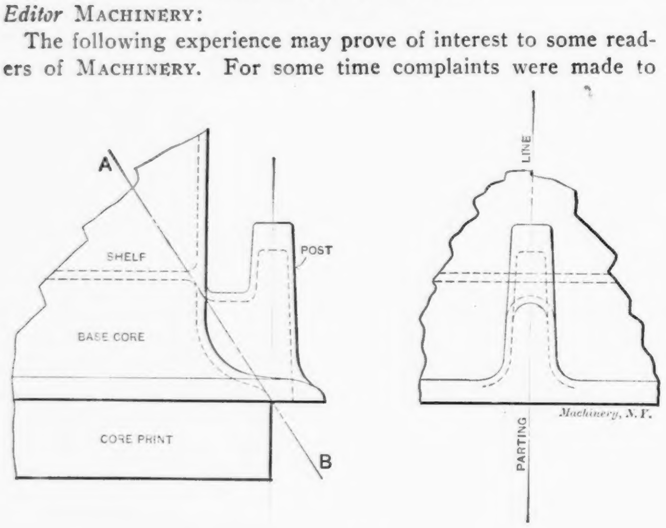
BELL CRANK.

* * *

HOW AN OBJECTIONABLE FIN IS PREVENTED IN A LARGE CASTING.

Editor MACHINERY:

The following experience may prove of interest to some readers of MACHINERY. For some time complaints were made to



SKETCH SHOWING METHOD OF ARRANGING CORES.

the foundry foreman that a fin in one of the large castings made for the shop caused much trouble. It was necessary to chip and break the fin so that a shaft could pass through the hole without interference. This chipping was no light task. The complaint was offered from time to time, but as no remedy was applied except a little more care in moulding, the fin continued to appear more or less with each casting. I was inspecting the patterns one day when the man in charge of the floor called me down (so to speak), giving me to understand that I was to have the pattern fixed, or do something to prevent the fin. Well, I was a little surprised, yet had to admit that the fin was surely objectionable and ought to be removed. I did not know that I had anything to do but to see that the pattern measured all right.

The cause of the fin can be easily explained by referring to the sketch. You will notice that the post is near the base so that it can be cored with the base and is also on the parting line. The base cores are in halves and are anchored to the flask.

It was only natural that the moulder should not want the projecting post part of the cores to come together when he closed his flask before the body of the cores met; if they did, the post part was in danger of breaking. So he filed a liberal clearance at the post part giving, as can be seen, a fin of varying thickness when the casting was made.

Thinking over the matter, I saw there was no good place to support an independent core without some trouble in setting. Then an idea came to me: Why not cut off the post part of one core just at the body before baking, then, after baking, paste this piece to the other half of the core, making the post part solid?

I spoke to the core-maker about the scheme and he approved of my suggestion. He cut one core as indicated by the line A—B, and after baking pasted it to the other half core. We made the cut wide enough to prevent interference of cores when the flasks were put together. This gave a fin on the line A—B, but no harm could come of it there.

When I told the man in charge that there would be no more fins in that part of the casting his pleased look and remark: "That is the way it should be," made me feel that I should like to have him mention some other trouble for me to remedy.

Providence, R. I. EDWIN C. THURSTON.

* * *

A NOVEL LATHE TESTING MACHINE.

Editor MACHINERY:

Two subjects treated in your November issue, "Turning Crank Shafts" and "Testing Engine Lathes," brought a smile to my face at the recollection of an incident which I will relate. Some years ago I had occasion to turn crank shafts for gas engines and, to facilitate the work, I hit upon the precise method described by Mr. De Sanno. The most marked immediate result of my plan was that my most capable lathe man refused point blank to turn a crank shaft in that way. When I insisted, he picked up his tools and left me, saying: "I have turned hundreds of crank shafts and I guess I know how to turn them."

My scheme for testing an engine lathe may not be adopted generally as a "survival of the fittest," but it served its purpose and the work was quickly done. I had need to raise the headstock of an 18" lathe, to swing a piece too large for its normal capacity and to bore therein a somewhat deep hole, which needed to be true to size throughout its whole depth. To align the head to the ways, I took a piece of pine about 1"x2"x24" and caught one end of it in a chuck, fastening it firmly. I then took an ordinary "star candle," cut from it four pieces, each one about 1 inch long, and fastened two of the pieces with their own grease to the pine bar near the chuck so that they were opposite each other. The other two were fastened at the farther end of the bar. The axes of the pieces of candle were all radial to the center line of the bar. Now by using a keen cutting tool, I could turn the substance of the candle smoothly without any perceptible spring of the bar and thus, by careful calipering, determine when the headstock was brought to and clamped in perfect alignment with the lathe bed. The wicks, of course, were removed from the candle ends used. C. C. HILL.

Chicago, Ill.

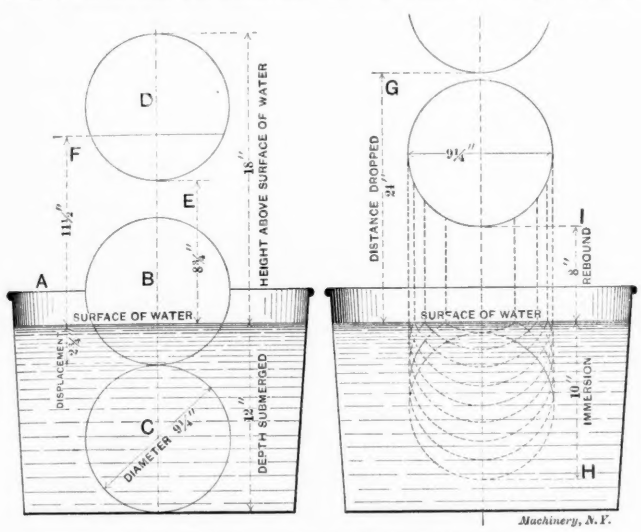
[It appears that this method of testing lathes is one that can be easily tried, and under proper conditions ought to give quite reliable results. Thus, a stick of pine wood, two or three feet long, and turned to a diameter that would leave a stiff and light bar, could be coated over with wax of a consistency that would allow turning with a minimum resistance to the tool, but still be firm enough for calipering. Such a test would be chiefly valuable for adjusting a lathe to bore accurately.—Editor.]

A PHENOMENON THAT APPEARS TO CONTRAVENE KNOWN LAWS.

Editor MACHINERY:

This phenomenon, which appears to be at variance with the known laws of nature, consists of the action of a hollow metal vessel of a peculiar shape, hermetically sealed, which, when submerged and released, will rise to the surface of the water with such velocity as to go beyond the usual limits of a floating body. It will rise in the air above the surface of the water. The movement of this body in ascending to the surface is opposite to that upon which the well-known law of retarded velocity is based. Instead of having a uniformly retarded velocity in rising, it has an accelerated velocity, induced by the pressure of the water upon its peculiar lines, independent of the buoyant energy. In ascending to the surface there is very little disturbance and it flies into the air as if released from a metal spring. When dropped into the water it rebounds into the air.

In drawing this vessel along on the surface of water mixed with meal, there is very little commotion among the particles of meal held in solution. They pass under and around and come back to their original position in the wake. Apparently, there is no dead water. In extending the lines of this object, they resemble somewhat the underbody of the modern racing machine.



ILLUSTRATING A PECULIAR PHENOMENON.

The results of several experiments are shown in the annexed diagrams. A is the tank containing water; B is the float at rest on the surface of the water, showing line of flotation and displacement; C shows the float submerged twelve inches below the surface; D shows the height above the surface of the water it will ascend after releasing; E shows the height from surface to bottom of float in the air; F shows the height above water of the line of flotation of the body in the air.

In the second diagram, G shows the distance the object is dropped to the surface; H shows the depth of immersion; I shows the distance it will rebound into the air. From the performance of this vessel through and on the surface of water, there is a remote possibility of its containing that which is much sought by yacht builders, the lines of least resistance.

Who will offer an explanation of this peculiar action?

Norfolk Navy Yard. GEO. C. STANLEY.

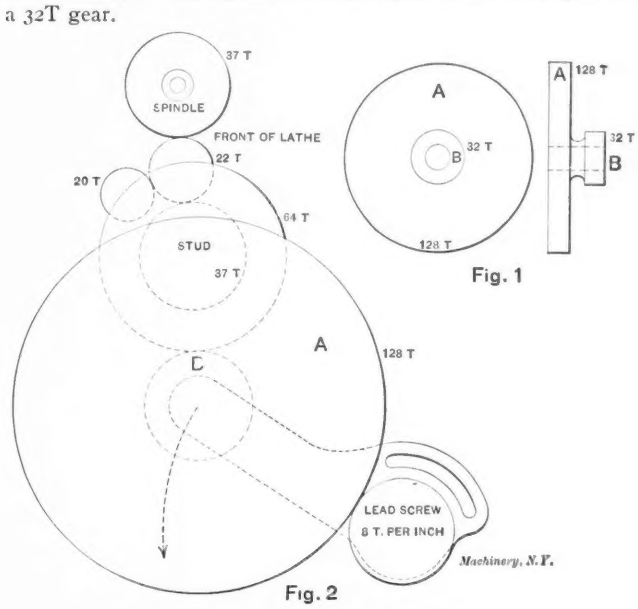
* * *

A PRACTICAL PROBLEM IN THREAD CUTTING.

Editor MACHINERY:

I have a problem in cutting a worm for a small engine which is being built in our shop and would like to have it shown up so that the readers of MACHINERY may answer it if possible.

The worm required is octuple, being one thread to the inch pitch and eight threads around the circle of a 5/16" rod. A large gear could not be used on the stud of our lathe and no provision has been made in its construction for compound gearing. In consequence, we cut a double gear like the one shown in Fig. 1, in which the large gear has 128 teeth and the small one 32 teeth. The hole through this gear was made to fit the intermediate stud of the lathe. Then by putting a 64-tooth gear on the stud, so that it would mesh with a 32T special gear and having a 32T gear on the lead-screw meshing with the 128T gear we obtained a ratio of 8 to 1 between the lead screw and the stud. The lead screw of the lathe has eight threads per inch, so with this combination we had the lathe rigged to cut a 1 inch pitch screw. The arrangement of the gearing is shown in Fig. 2, which shows the 64T and 37T gears on the stud, the 22T and 20T tumbler gears in the headstock and the two 37T gears on the stud and spindle. All the other gears are outside the headstock, being one 64T gear with a 32T gear and a 128T gear with a 32T gear.



ARRANGEMENT OF GEARING FOR SCREW CUTTING

With this arrangement of gearing, I cut a thread and ran the carriage back to the starting point and after pulling the belt down towards me to take up all lost motion, I loosened the nut which holds the special gear up to the 64T gear and the arm holding the special gear dropped down till it cleared the 64T gear on the stud. Then I turned the lead-screw through one revolution and put back the intermediate 128-32T gear in place, cut another thread and so on. I found that I could cut eight parallel right hand threads very well that way, but the "boss" requested me to cut a left-handed thread of the same pitch and the same number of threads and here I met the "sticker." I proceeded as before, only changing the lever in the headstock so that the 20T gear was driven by the 37T gear, the 22T gear by the 20T gear and the 37T gear on the stud by the 20T tumbler gear. I took up all the lost motion, ran the carriage back to starting point, turned the lead screw once around and cut the thread. When I got through I had nine parallel threads instead of eight as before.

Can you explain why I got one more thread left-handed, and why if the lathe cuts right and left-hand worms the same pitch with the same gears, I obtained one more thread under these circumstances. I send you a sample piece of brass having right and left worms cut to show you the eight and nine parallel threads. I am very anxious to get at the bottom of the difficulty and hope for satisfactory solution.

Poughkeepsie, N. Y. EDWARD O. JOHNSON.

* * *

NUMBERING PATTERNS AND DRAWINGS.

Editor MACHINERY:

Here is a system for numbering patterns and drawings which has proved very successful, and to illustrate it I will use the drawings and patterns of a 14" lathe. When a machine is designed it is given what is termed a machine letter. In the right hand corner of every sheet of drawings will be found the name of the machine, the machine letter, the sheet number and the scale size, as shown in Fig. 1, of the accompanying sketches. These sheets are filed in cases containing drawers, each drawer being numbered by a letter. The drawings having been placed on file, the question arises how can any particular sheet be found without beginning at the top and looking through each drawer? This obstacle is overcome by adopting the card shown in Fig. 2. In the center of this card, at the top, are written the name of the machine and the machine letter; at the left of the card, the number of the sheet of drawings; in the next space to

the right which drawer the sheet is in; next, which case contains the drawing in question; after that, and lastly what part of the machine is contained on a sheet of drawings of any number.

It will be noted that the card shown in Fig. 2 is for detail drawings only. A number of our machines, however, are designed with an assembly drawing, and these are placed in a separate case and are designated by the name of the machine and by

14-INCH LATHE.
MACHINE LETTER
B
SHEET NUMBER—501.
SCALE—1-2 SIZE.

FIG. 1.

the machine letter, as shown in Fig. 1. To make the card shown in Fig. 2 more definite, a space at the bottom of the card is marked "assembly," and a cross is placed next to it if the machine to which the card belonged has an assembly drawing. See Fig. 2. Thus, with one glance at the index card, one has the numbers of sheets of drawings used on each machine, which sheet contains any particular part, where to find the sheet

14-INCH LATHE.
MACHINE LETTER—B.

Drawing Number.	Drawer.	Case.	Detail.	
501	B	1	0	Carriage.
502	B	1	0	Head Stock.
503	B	1	0	Tail Stock.
504	B	1	0	Bed.
505	B	1	0	Legs.
				Assembly +

FIG. 2.

wanted, and whether there is an assembly drawing of the machine. These index cards are filed away in pigeon-holes numbered with letters corresponding to the first letter of the name of the machine.

Now, regarding a system of marking patterns and indicating the number of castings used from each on a machine, I decided that the index card shown in Fig. 3 would suit all my requirements. At the top of the card is the name of the machine, and

14-INCH LATHE.
MACHINE LETTER—B.

Drawing Letter, B. / Sheet No.	Piece.	Number of Parts Used.	Pattern Number.
501	Apron.	1	133
501	Hand Wheel.	2	135
501	Feed Worm.	1	138
504	Bed.	1	140

FIG. 3.

directly under is the machine letter; at the left are the drawing and the machine letter, and directly under that can be found the number of the sheet of drawings. In the center are the names of the patterns; in the first column on the right, the number of castings used for each pattern on one machine, and the last column gives the number of the pattern. For example, if a casting for a feed-worm is needed, I look for the 14" lathe in the pigeon-hole marked L. I find the pattern number for the feed-worm to be No. 138; I find that there is one used on a machine and that the sheet of drawings that contains the feed-worm is 501. I now have the desired information and despatch a boy to get pattern No. 138 for 14" lathe, and send it to the foundry, as the card tells me that is what I need for one machine. This system saves a great deal of time, and the drawings and blue prints last longer because they do not receive so much handling.

Having my patterns distributed among a number of foundries, if I wanted a pattern and it was not where it should be, of course

14-INCH LATHE.
MACHINE LETTER—B.

Pattern Number.	Piece.	Received by.
140	Bed	

Date Received............. October 7-98		Number Ordered........... 1
Date Returned.............		

FIG. 4.

I would know it was in the foundry, but in which one could not be told. For this reason I adopted the system shown in Fig. 4. At the top of this card is written the name of the machine, directly under, the machine letter and the name of the piece; at the left is the pattern number; at the right a space is left for the signature of the foundry holding the pattern; at the bottom the dates the pattern is received and returned and the number of castings ordered.

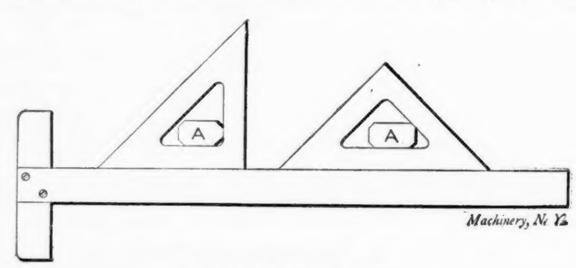
Some of the readers of this article may say that there is a lot of red-tape and unnecessary printing to this system, but I find that the time saved by adopting it more than pays for the printing. Then, too, I always find the patterns returned in good condition, because I have the receipt for same which holds the foundries responsible for the patterns. A. Notroth.

* * *

SECTION LINER.

Editor Machinery:

In your November number I noticed, under "Shop Kinks," a section liner for draughtsmen. There was one suggested to me while I was attending Purdue University which is easier to make and to operate, besides giving two spaces. It consists of a piece of thin wood, cut a little smaller than the opening in a triangle, as shown in the sketch, and it works by alternately



SIMPLE SECTION LINER.

sliding the block A and the triangle. By sliding the hypothenuse of the triangle along the square, another spacing may be obtained. The block may be whittled out with a jack knife, as it requires no planed edges, and I think the greatest advantage is that it helps to hold the triangle against the tee square, while the one described by Mr. Ish does the reverse.

Chicago, Ill. Paul C. Van Zandt.

* * *

NOTE ON BEVEL GEAR CUTTING.

Editor Machinery:

Many manufacturing concerns, who make a standard line of machines, and who have occasion to cut bevel and mitre gears on automatic bevel gear cutting machines, may have some difficulties in cutting certain gears, or possibly they think it is much easier to cut bevel gears, such as shown in the accompanying sketch, on universal milling machines. It can easily be seen that it would be difficult to lay off the depth of the tooth on the large end. To cover such cases, and to make the setting of the cutter easier for the operator, especially for one whose knowledge of

gear calculations is limited, the following method was determined upon. It can be used on any style of bevel or mitre gear that can be cut on an automatic gear cutter, where the feed, instead of being at right angles to the pitch cone is at right angles to the axis of the gear, as, for example, in the "Brown & Sharpe" automatic bevel gear cutter. On a universal miller the gear would be placed at such an angle that the line O H in the sketch would be parallel with the direction of the feed, and the cutter would be fed in to the required depth D H.

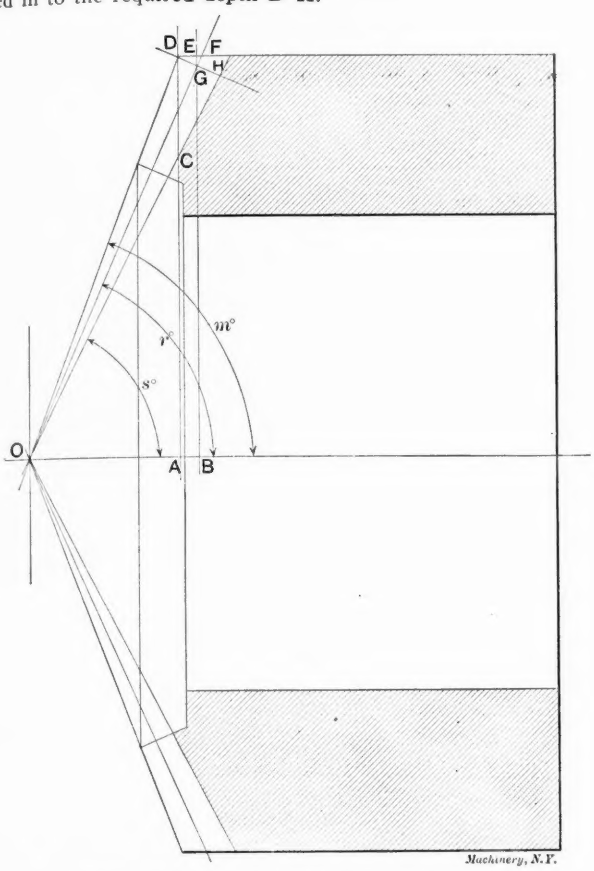


DIAGRAM TO ILLUSTRATE SETTING OF CUTTER.

When the gear blank is stationary and the cutter is set to the required angle s, the depth the cutter is moved into the work is not D H as before, but D C. To determine the line D C on any bevel gear having a diametral pitch is the object of this article.

Let line G B equal one-half the pitch diameter of any gear. D A equals one-half the outside diameter. Angle r equals one-half the pitch cone. D G is equal to $\frac{1}{\text{Pitch}}$. Then angle D G E is equal to r, being the complement of O G B. The sine of angle r times $\frac{1}{\text{Pitch}}$ is equal to line D E, or A B. Line O B is equal to ½ pitch diameter of the meshing pinion or gear.

In triangle C O A, angle s equals angle at which gear is to be cut. The tangent of s times O A is equal to A C. A D minus A C is equal to D C, which is the required distance that the cutter must move into gear blank to obtain a perfect tooth.

Some may think it easier to lay-off a full-sized section and measure the distance with a scale, but where the feed is graduated on the machine it seems to me better to compute the exact distance in thousandths and use such graduation, and then there is no guess work about it.

E. M. WILLSON.

Madison, Wis.

* * *

COUNTERBORING TOOL AND OTHER DEVICES.

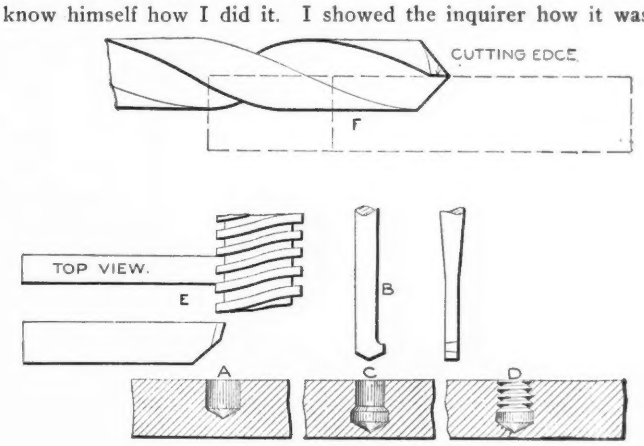
Editor MACHINERY:

It often happens on small work that thin pieces have to be tapped with a small tap, and that the holes must not be drilled clear through. To get as many threads as possible, the piece has to be tapped right down to the bottom, and the result is that in this kind of work many of the taps break off. There is a way to prevent this breaking off of the taps. First, with a common flat or twist drill, such as shown in the accompanying sketch, drill all of the holes down as far as you want the thread to go. After this take a drill, such as the one shown at B, and drill down, say, 1-16" or 1-8" more, as shown at C. This drill will counterbore the bottom and give the tap a chance to go clear down. The drill shown at B is only a flat drill, the same size as the first one, but ground one sided, as shown in the figure. When drilling down with this drill it will start to counterbore at once, and as soon as it has made its size it will continue to bore that way. D shows the same hole after being tapped.

Any machinist who gives this simple tool a trial will soon find it a very useful one for many things.

Some years ago I worked in a medium-sized shop where we had quite a good deal of brass work. Among other things we had a lot of valves with double thread on the stem and nut.

When I first came to this shop the stem was cut in the usual way. First one thread was cut, then the gears were turned half way round and the other thread was cut. It was quite a job to make all these changes to cut each thread, and it caused a great loss of time. As I was cutting some of these valve stems one morning, the thought struck me that if I had a double tool just the pitch from one thread to another, I would be able to cut a double thread at one setting and to cut two valve stems in the time that it now took me to cut one. I went to work at once and made a tool like that shown at E. When it was finished I gave it a trial and it worked like a charm. There was another man in the shop doing the same work, and about two days later he came to me and said that the boss had been trying to bluff him by telling him that I was making two valve spindles in the same time he took to make one. At that time the boss did not know himself how I did it. I showed the inquirer how it was



A FEW KINKS.

done and the next day he was using the same sort of a tool.

Every machinist knows how easy it is to break a twist drill when drilling brass. The kink I am going to tell about is nothing new and I have been using it for years. The wonder to me is that so few have caught on to the trick. When I have to drill a lot of holes in brass, I take a common twist drill and grind its cutting edge with an oil stone, just rubbing the oil stone up and down once or twice, holding it exactly in line with the center of the drill. The end ground off would be in the same state as a straight fluted drill, as shown exaggerated at F. Grinding off the cutting edge of the drill will prevent the drill from screwing into the brass and from breaking when it is nearly through. It will also save the operator's hands. The cutting edge needs only to be ground off about 1-100 part of an inch.

If the drill is to be used afterwards for steel or iron, it can be used as it is or ground off again in a few seconds.

OLD SUBSCRIBER.

* * *

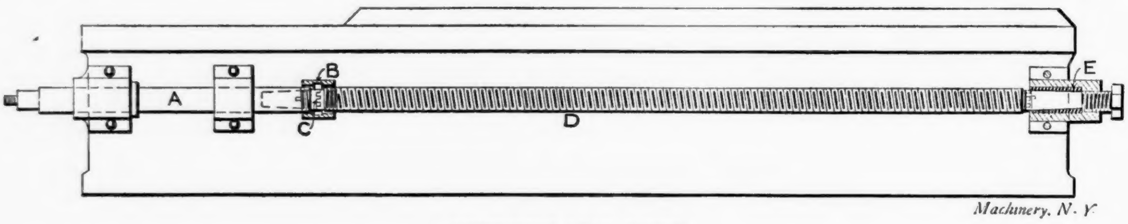
REVERSIBLE LEAD SCREW.

Editor MACHINERY:

It is often requisite to cut an accurate screw in a lathe the full length of its center distance. With a new lathe this is an easy matter, but with a lathe that has been in use for some time it cannot be done with any degree of accuracy owing to the unequal wear in the lead screw, unless the lathe has been in continuous use on full length work. The inequality of wear is due to the greater portion of work being short or half length

and to the pull on the screw being in one direction. In fact, some lead screws assume the buttress shape of thread toward the head stock, while the part toward the tail end is as good as when it left the factory.

With the present construction of the lead screw there does not appear to be any remedy for this. To trim the threads to their proper shape would make them too light for practical use, and to propose a new lead screw to the proprietor of a machine shop would be as bad as committing a felony. It seems to me that the solution of the difficulty would be to have the lead screw reversible. It is evident that with a reversible end screw, the wear would be evenly distributed throughout the length of the screw by reversing the ends every three or six months.



REVERSIBLE LEAD SCREW.

The sketch shows a reversible end screw which, I believe, with a few slight alterations, could be used to good advantage, as it possesses the rigidity of the solid screw, and does not take two days to be reversed. The stationary part of the screw is fitted with a clutch end C and a socket. The reversible part D is fitted at both ends with a clutch and has slightly tapering shanks. A right-and-left threaded nut B holds the stationary and reversible parts firmly together, the clutch preventing them from slipping. The part where the clutch engages should be turned slightly smaller than the screw. Should any burring occur from their engagement, this will prevent the nut from being injured. The tail end bearing is fitted with a bushing E to receive the shanks and it turns in the bearings, as it is obvious that if the shank were allowed to turn in the bearing, it would in a short time be too small for the stationary end. To reverse the screw it is only necessary to take off the tail end bearing and disengage the screw by the use of the right-and-left threaded nut.

T. B. C.

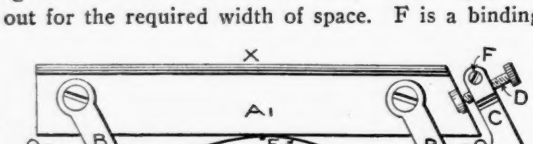
* * *

A SECTION SPACER.

Editor MACHINERY:

An expert and experienced draftsman on ordinary mechanical drawings needs no mechanical spacing device for section lining; that is, practice accustoms the eye to quickly locate the straight edge so nearly uniform in spacing that the general appearance is good. On the other hand, there are times when an accurate division of space is desired.

The accompanying cut is one of many devices which can be used for this purpose. A A_1 are two pieces connected by connecting links B B, which allow A_1 to be moved between stop pins O O and regulating screw D. A is provided with arm C through which is threaded the screw D, which may be turned in and out for the required width of space. F is a binding screw



so that D may be made to move with the degree of friction necessary to keep it from jarring loose when set as desired. A_1 is bevel-edged at X for pen lining. Between A_1 and A is a light spring, which may be made to act as a spreading-apart spring or to draw them together at O O, as might be most convenient to the operator. The operation of this device may be readily seen by those accustomed to section lining, but I must add that proficiency in using any device of this kind is only attained by practice.

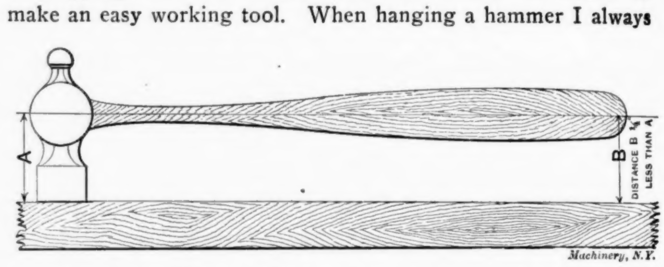
FRANCIS W. CLOUGH.

Boston, Mass.

HAMMER HANDLES.

Editor MACHINERY:

The "loose pulley" illustrated in the December issue of MACHINERY is all right, but it is not the particular kind that the writer cares to meet. I notice that the editor has placed the sketch beside the obituary column, which appears quite appropriate. What I desired to mention, however, is the hammer that is dropping from the unfortunate gentleman's hand. The artist who drew the sketch evidently appreciates what the correct form for the handle of a machinist's hammer should be. What a difference there is between the properly-hung hammer, having an elastic handle and the club arrangement that some men use. A handle that has not been reduced to the proper dimensions near the head is a most tiresome tool for me to use, and I almost invariably hang a new handle myself instead of letting the shop carpenter do it. A carpenter understands a nail hammer all right and knows that it should properly have quite a stiff handle, but a chipping hammer handle must be elastic in order to make an easy working tool. When hanging a hammer I always



have it so that the face is inclined inward towards the axis of the handle. That is the handle will not stand parallel to the top of the bench when the face lies squarely against it, but will be "hung in," as shown in the accompanying sketch.

A hammer having a good hickory handle and reduced to the proportions indicated, is a comfort to use and "swings itself," as the shop saying goes.

NEMO.

Providence.

* * *

HOW HE HARDENED THE DIE.

Editor MACHINERY:

One day, while I was at Smith & Black's, we had a new man come to work in the tool room. He was one of those slap-dash and let-her-go kind of men. The foreman looked him over well and started him in on a large blanking die, which was, if I remember rightly, for a pair of sugar tongs. He started in pretty well for a new man, made the die all right, and then went out in the smith's shop to harden it. Now, we used to have a fire out here just for the tool makers, as well as one used by the smith. The new man piled on the coal, got up a big fire, and then put in his die to harden. It was about twenty inches long, and I think it was of steel, 1 x 3 inches. The smith's fire was an ordinary one, about ten or twelve inches diameter, and he slapped the die on the top of it, put on the blast, and kept pulling his work back and forth through the fire, so as to try to get an even fire. He heated the die up after a fashion and then started for the hardening tank. Now, we did not have very good hardening facilities. All we had was a tub about 16" square and 20" deep, and there was about 10" water in it at the time. What did that fellow do but stick one end into the water as far as it would go, then pull it out, turn it over quick, and stick in the other end. He repeated this operation several times, then pulled the die out, pronounced it hardened, took it into the shop and polished it up, and then tried to draw the temper. The thing was hard at each end and soft in the center, and as soon as he started to temper it, it went all out of shape, like a sprung

wheel on a bicycle. "Of all the poor steel I ever saw that is the worst," said he, as he took it up to the boss' bench.

"Yes, it did go pretty bad," said the foreman, "and I guess you had better go, too," and he went. A. P. PRESS.

* * *

A NEW PLANER TOOL HOLDER.

A planer tool holder for the economical use of self-hardening steel, and one which can be adapted to a wide range of work, is shown in the accompanying cut, Fig. 1. The cutters used are of the regular stock shape, and can be cut from the bar without forging into shape, the required cutting edge being formed by grinding. The cutter is held by a slotted bolt through which it

FIG. 1.

passes, and is kept from slipping sideways by being seated in grooves in the holder. The shank is drop-forged from steel, and case-hardened for durability. It will be seen from Fig. 2 that this tool is well adapted to working in close corners and under projections, as the cutter can readily be set at any required angle and held firmly in the required position. One of the special tools that is often used on the planer is the "goose-neck," but it is a

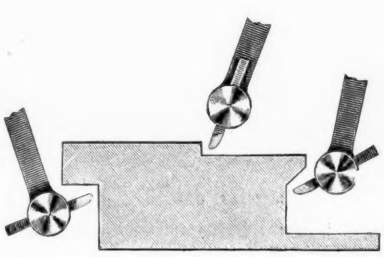


FIG. 2.

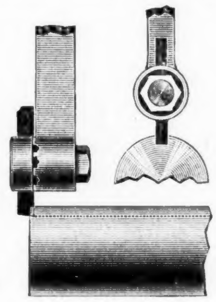


FIG. 3.

difficult and expensive form to forge. This tool fills the bill completely as shown in Fig. 3, where the cutter is reversed and the tool turned around so that the cutting edge is behind the center of the tool. Such a tool is of much value in cutting keyways, as there is no tendency to "hog in" and spoil the job. The tool-holder is manufactured by the Armstrong Bros. Tool Company, Chicago, Ill.

* * *

CASE HARDENING.

At the annuual meeting of the Railway Master Blacksmiths' Association there was an extended discussion upon case-hardening which is reported in the published proceedings that we noticed last month, and from which we quote the following:

"The process of case hardening has not changed, materially, for the past few years. The principal materials used remain the same, granulated raw bone, hydro-carbonated bone black, black oxide of magnesia, sal soda, charcoal, and salt. These materials are commonly used in railroad shops and give much satisfaction, if they be carefully and properly handled.

"The work, which is to be hardened, can be packed in cast, or wrought-iron boxes, sealing with fire-clay, or mud so as to prevent the gases from escaping as much as possible. The pieces to be hardened should be placed about two inches apart in the box. The vacant spaces are well filled, and packed with the material used for the case-hardening purpose. Should the box be supplied with heavy work, as crank-pins, guides, etc., fifteen to twenty hours of steady heat are necessary in order to secure the best results. If, on the other hand, you have light pieces, as link blocks and pins, eight to ten hours will be sufficient to subject them to a good heat.

"The work may be placed in the furnace, about 8 o'clock of a morning, and heated all day. At night close up the furnace, letting the box remain over night, and remove the next morning. Reheat the work and cool in cold water. Good results may be secured by using granulated raw bone. If using hydro-carbonated bone black, pack the pieces in the box and seal the same as before.

"Furnaces for case-hardening should be so constructed that the boxes will not have to be raised or lowered while being placed in or taken from the furnace. The heating space should be near the ground, and the fire-box and ash-pan below the surface. This refers to a furnace heated with soft coal. If the furnace is on the outside of a building, a stack or chimney about sixteen feet high will furnish draught enough to heat the boxes without the aid of a blast. Case-hardening furnaces, which are heated with fuel oil, are of a very different construction, the boxes being generally heated from the top. With coal it is, in most cases, from the bottom.

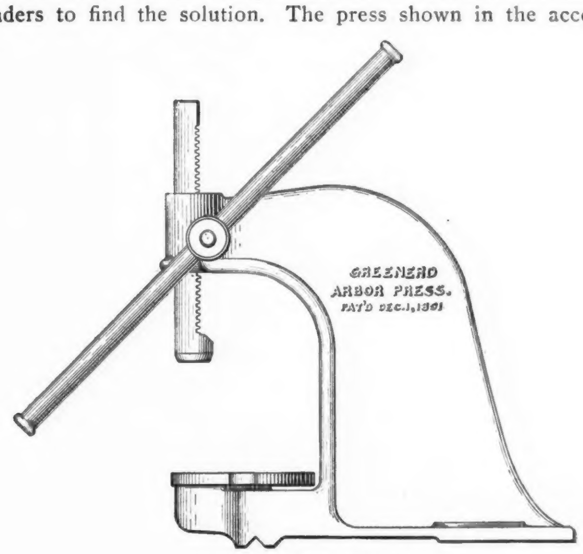
"The cooling tub is arranged so as to admit cold water from the end near the bottom, the cold stream thus running lengthwise along the bottom of the tub. This cold stream forces the hot water to flow over the top of the tub. When cooling guides, or long pieces, strips or bars of iron should be laid in the bottom of the tub, in order to keep the work about two or three inches from the bottom. In this way the cold stream flows under the work which is being cooled."

Another speaker said: "The way we do in our shops is to use potash and glue, the idea of the glue being simply to make the potash stick. We put on all the piece will take; if we desire more hardening we use a second coat of glue. We do not make the glue thin, but make it thick and put on all the piece will hold."

* * *

A PRACTICAL PROBLEM.

It is likely that most of the readers of MACHINERY are familiar with the Greenerd arbor press, either from practical experience with it in the shop or from the extensive advertising it has received. Many of the latter class, having never had an opportunity to give one of these presses a practical trial, have probably felt somewhat doubtful of its ability to force a mandrel into a bore with the pressure that can be exerted by a sledge in the hands of a lusty mechanic. It is thought that a practical problem is involved in this device, of which it will benefit some of our readers to find the solution. The press shown in the accom-



TYPE OF ARBOR PRESS.

panying outline sketch is one for pressing in arbors of a diameter up to $1\frac{1}{2}''$ and the largest diameter of work that can be centered under the plunger is $12''$. The length of the lever is about $23''$ from the end to the center of the shaft carrying the pinion. The diameter of the pitch line of the pinion is one inch.

What pressure can a man easily exert on an arbor and how will that pressure compare with the average blow of a five-pound hammer? Suppose a $1\frac{1}{2}''$ arbor is forced into the bore of a pulley $10''$ in diameter by the pressure found in the first instance, what pull at the rim would be required to slip the pulley on the mandrel? Answers to these questions may be found either by experiment or calculation as the reader may elect.

A NEW BORING TOOL HOLDER.

The illustration in Fig. 1 is of a new boring tool designed to be placed on top of the tool post slide of an engine lathe. It will be seen, by reference to this illustration and to the detail sketch in Fig. 2, that a shoe B, rests on top of the tool post slide and supports a swivel frame, C; the whole being clamped together by a bolt which passes through a cylindrical clamping beam D fitting inside the swiveled frame. This frame has two bearings, I ,which receive the boring bar

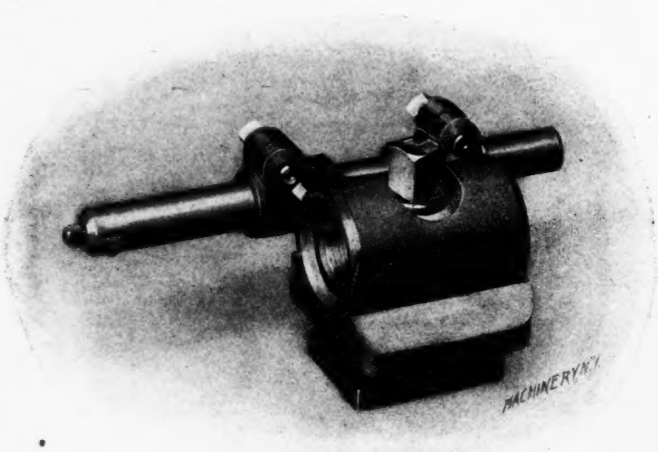
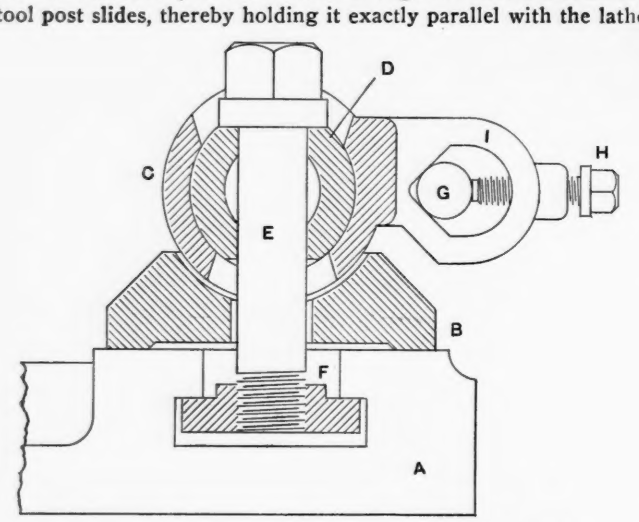


FIG. 1. BORING TOOL HOLDER.

Two forms of this holder are made; one like that in Fig. 1, in which the bearings have round holes adapted to receive round bars of exact size; the other, shown in the sectional view, has V-shaped bearings suited to octagon or other shapes of forged bars from ¼" diameter to the largest size required. In special cases the shoe may be made with a tongue to fit the slot in the tool post slides, thereby holding it exactly parallel with the lathe



Machinery, N. Y.

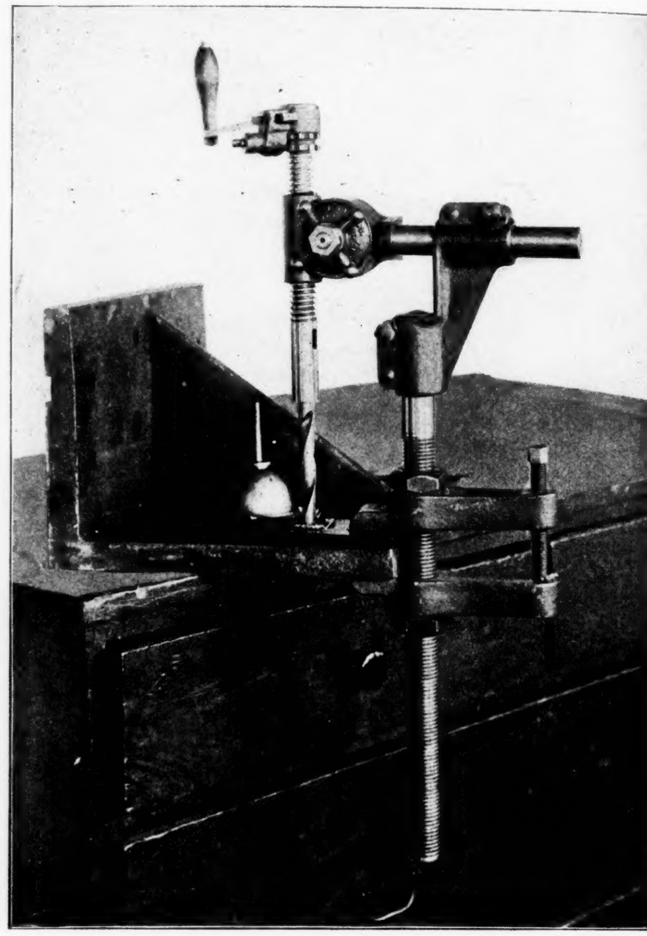
FIG. 2.

ways. Usually, however, the operator prefers to locate the angle of the bar to suit his work, and in boring a back-taper hole this is indispensable. In adjusting the cutter bar to the correct height, the clamping bolt is tightened only slightly so that the frame can be tilted up or down to bring it in the desired position. When the cutter is at the proper height, tightening the bolt moderately, makes the whole immovable, in, fact, almost as rigid as solid iron. This tool is made by Jas. Dangerfield, Elgin, Ill.

* * *

UNIVERSAL HAND DRILL.

The drill shown in the accompanying illustration is of new design and is intended for a wider range of work than can be accomplished with an ordinary ratchet drill. At the same time it can be used wherever a ratchet drill is applicable and is more rapid in its action because it has an automatic device which gives a regular feed when the handle is operated by the workman. The drill is universal and can be set at any angle. It is made in five sizes which adapts it to holes varying from the smallest to those 1½" in diameter. The feeding arrangement consists of a friction disc in connection with a worm gear which operates in the rod of the spindle and advances the drill at the required rate of feed. The speed of the feed is changed by tightening or loosening the friction wheel.



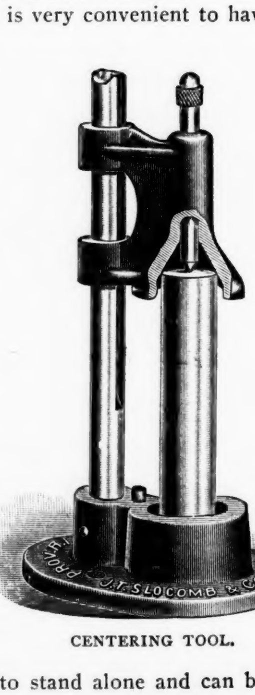
THE DRILL IN ACTUAL USE.

The handle can be changed so as to be used as a crank or as a ratchet working in either direction. The drill column can be readily attached to any kind of work and is found valuable for use on large work or in making repairs, because of its general convenience and rapidity. It is manufactured by E. D. Jones & Sons' Co., Pittsfield, Mass. The illustration is made from a photograph taken in the shop, which shows the drill as it appears in every day work.

* * *

A NEW CENTERING TOOL.

A simple centering tool which is very convenient to have in a shop where much small lathe work is being done, is shown in the accompanying cut. The Severance centering tool, as it is called, is a combination of the principle of the bell center punch and an upright support, together with a cast-iron base. The upright shaft is splined and a key in the bell part keeps the bell centered over the recess in the base, in which the end of the piece being centered, is placed. The base may be screwed to the bench and the arrangement made a much more convenient scheme for centering the work than the old-fashioned bell center punch that has to be held in the hand. The tool need not be fastened down, however, as it has enough stability to stand alone and can be used



CENTERING TOOL.

without being fastened if desirable to have it in different parts of the shop. To avoid disagreeable noise and dangerous shocks to the tool from the bell falling on the base after being used, a small rubber plug is inserted in the base to act as a buffer. The center punch is made of the best steel and is carefully tempered as such a tool needs to be to stand the rough usage that it will almost invariably receive in the average machine shop. The tool, as at present made, will center diameters from 5-16" to 1½" and lengths to 12". It is manufactuied and sold by J. T. Slocomb & Co., of Providence, R. I.

* * *

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

26.—L. T. W.: Will you kindly give me directions for balancing a vertical engine. Should the cross-head, piston, and connecting-rod be attached to the shaft and balanced with it? I have been told that they should be but I do not think so.

A.—On page 361 of the July, 1898, issue, you will find information on balancing a vertical engine. Aside, however, from an explanation of the principles involved, the conclusion is reached that the only satisfactory way to balance the engine is by experiment. The cross-head, piston and connecting-rod cannot be correctly balanced by a revolving counterweight; but the only feasible way is to couple up the engine and balance these parts as nearly as possible by the use of such counterweight. The engine can be made to run smoothly by this process, and that is all that is required.

27.—Referring to the article on "Wireless Telegraphy," which appeared in the November issue of MACHINERY, T. I. J. asks: How is the circuit of the cells of battery R, as shown in Fig. 2, closed by the armature of the magnet B? The diagram shows only one point of contact. 2.—Can all of these magnets not be arranged in series in their separate circuits and without the use of resistances in shunt as shown? 3.—Also, please describe more fully the resistance tube A, Fig. 3. What inside diameter is best to use to receive a coil which will give, say an 8" spark between secondary terminals? How far apart should the heads of the conductors be and what kind of filings should be used, and of what size, fine or coarse? 4.—When should the hammer strike the tube?

A.—In Fig. 2 of the article referred to the artist neglected to draw a short line connecting the right hand side of lever with the line above, which connects the ends of magnet coils C and D. By drawing in this line you will find that the two coils are connected in parallel with the battery. The coils can be placed in series without affecting the operation of the apparatus, but the resistances cannot be discarded, as their object is to prevent sparking at the break points. Sparking must be prevented at these points, for if not, radiations would be developed by them, and these would act upon A and thus confuse the signals. The only objection to the series arrangement of C and D is that the sounder D would vibrate, and thus render the signals less clear. The tube A is made about ⅛ of an inch in diameter, inside, and the distance between the ends of the wires is about the same. Fine nickel filings are considered the best for the filing. The arrangement illustrated in your sketch is all right, but if the two magnets were placed in parallel the sounder could give regular taps. The tapper is under the control of the high potential current coming from wire W, for each time it raps the tube, it decohers it, as it is expressed, which means that it restores the natural state of high resistance. If the high potential current ceases at the instant when a tap is given, this will be the last one, for when the next one should be given there will not be a high potential current to break through A.

28.—A. A. L. asks for directions for grinding ammonia cocks. He states that he has difficulty in making them tight and that, after grinding a while, he finds that rings appear on the surfaces. We referred this question to Mr. Francis H. Boyer, Somerville, Mass., who replies as follows: To grind ammonia cocks satisfactorily a lathe is required. Put a dog on the round stem and place the plug on the centers with the tail stock run well back. Have the body of the cock so that it can be pushed over the plug and run your lathe on quick speed. Wipe off the plug and bore, place on the plug a thin coating of flour emery and oil and then grind for short periods, say eight or ten seconds. During the grinding every ten or fifteen minutes wipe off the plug and the bearing in the body and apply clean emery. Should you not have a lathe convenient, clamp the round end of the plug in a vise with soft jaws, putting pieces of sheet lead or copper between the jaws and pin, and then grind the same as for lathe work, turning the body of the cock by hand. To avoid cutting rings or scores in the surfaces, lift the body from the plug every few seconds, clean off the surface often and apply new emery. This will give a most satisfactory result.

29.—J. T. B.: Will you kindly give me some information on draw plates used in the foundry? I would like to see a sketch of one if possible.

A.—Draw plates are commonly made like the sketch at the left in Fig. 1, which consists simply of a small metal plate with a hole drilled and countersunk in each end for wood screws and

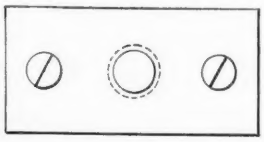


FIG. 1.

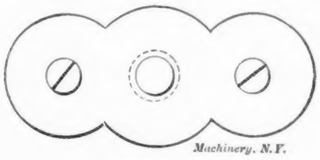


FIG. 2.

a ½" tapped hole in the center into which a threaded rod can be screwed for withdrawing the pattern from the mold. Another form of draw plates, which we believe is patented, is shown at the right in the sketch. It is made in such a shape that, by boring three shallow holes in the pattern with a bit, the draw plate will fit into these holes.

30.—H. W. S.: I would like to learn more about lubricants and the subject of lubrication. You will do me a great favor by informing me how I may best obtain a thorough understanding of the subject.

A.—A book by Redwood upon "Lubricants, Oils and Greases," price $1.50, and another work by Robert H. Thurston, on "Friction and Lost Work in Machinery," price $3.00, will probably help you to a better understanding of the subject. We can supply these books at 10% discount from the list price.

31.—H. T. H.: 1.—I would like to know what is the best method of treating steel to prevent it from rusting. The steel is constantly exposed to the weather and occasionally two pieces of the metal rub together. Of course there are many ways of treating steel that answer the purpose where there is no rubbing; but in this case any coating is soon worn off and corrosion begins. 2.—Will you also please state how barbed wire, used for wire fences, is treated.

A.—1.—There is no way to prevent steel from rusting other than by giving it a coating of some other material which will not corrode and which keeps the air and moisture from the steel. It is evident that if steel were subjected to some treatment which acted throughout the metal, you would no longer have a piece of steel. It is the nature of steel to rust, and if it were so changed that it would not rust, it would no longer be steel. In this connection it may be interesting to note several methods that are used to prevent rusting. Tinning is a coating applied by first scouring the metal, then dipping it in acid, then in grease and finally in melted tin; galvanizing consists in coating the metal by a similar process with zinc. Tin is negative to iron, and zinc is positive to iron, electrically, so that when the coating becomes injured, the zinc will actually protect the iron while the tin will cause an action to take place which will produce rust. Nickel plating is negative to iron and does not protect it as well as galvanizing, but it is a durable coating. Iron or steel can be protected for a long time by dipping in molten tar. Linseed oil, on oxidation, forms a rubber-like substance which has great preserving power and when used either with or without coloring matter is a good preservative. 2.—Barbed wire fences are generally galvanized.

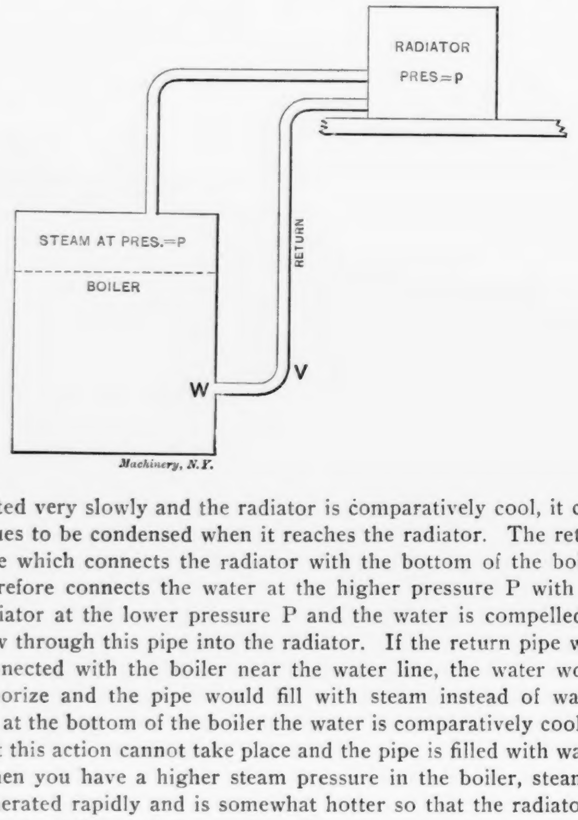
32.—R. T. W.: 1.—In the February, 1897, number of your paper, you published an article on annealing Mushet steel. Has the annealing of this class of steel come into extensive use since that time and do you know of any later methods of performing the operation? 2.—Does the steel, after annealing, show the same properties of self-hardening when heated again?

A.—On page 263 of the April, 1898, number you will find a little information upon annealing self-hardening steels. We do

not know of any later methods and we think that in most shops the annealing is not very generally practiced because it is done with difficulty and steel can generally be ground into the shape desired. 2.—Upon heating again, the steel will regain its former properties. Of course, where milling-cutters, taps and dies and similar tools are made of this steel, it must be annealed. In hardening, the steel should be heated to a bright yellow and cooled in an air-blast.

33.—H. H.: I have been piping a house for steam heating, using an upright shell boiler for a heater, placed in the cellar. When I start the fire and the boiler begins to make steam, the water will go out of the boiler, through the return pipe, and fill the radiators. If I close the valve in the return, however, and do not open it until there are two pounds pressure in the boiler, there is then no difficulty with the water backing up into the radiators. Please tell me what the trouble is and how to remedy it.

A.—If you will put a check valve in the return pipe near the boiler you will probably have no trouble. We think the explanation of this peculiar action is as follows: Suppose that you start the fire and steam begins to generate, reaching a pressure, say of ½ pound per square inch. The pressure P above the water in the boiler as shown in the sketch will then be 14 7-10 pounds due to atmospheric pressure, plus 5-10 pounds. This steam rushes into the radiator, which is cold and acts as a condenser. After partially filling the radiator, it condenses, leaving the pressure P in the radiator something less than atmospheric pressure, or in other words producing a partial vacuum in the radiator. Steam continues to pass off from the water, keeping up the pressure in the boiler, while as at this stage it is generated very slowly and the radiator is comparatively cool, it continues to be condensed when it reaches the radiator. The return pipe which connects the radiator with the bottom of the boiler, therefore connects the water at the higher pressure P with the radiator at the lower pressure P and the water is compelled to flow through this pipe into the radiator. If the return pipe were connected with the boiler near the water line, the water would vaporize and the pipe would fill with steam instead of water; but at the bottom of the boiler the water is comparatively cool, so that this action cannot take place and the pipe is filled with water. When you have a higher steam pressure in the boiler, steam is generated rapidly and is somewhat hotter so that the radiator is heated quickly and the condensation does not take place to so great an extent as to produce a vacuum. The pressures in the system are consequently balanced and no trouble ensues.



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The Arthur Company Machine Works, 188-190 Front street, New York, are doing an increasing business in high-class work and are constantly adding to their plant. In their gear department we have examined two 6 foot machines of entirely new design, and found them being tested, with the most satisfactory results, on 50 inch wheels of 2 diametral pitch. All their large gear cutting machines are designed and built on the premises, and these two are their third and latest type. So thoroughly have these machines met expectations, that two more of the same style, powerful enough to carry cutters up to 8 inches diameter and cut still larger pitches, are now under construction to meet the growing demands for greater diameters and pitches in cut gearing.

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OBITUARY NOTES.

Philander P. Lane died at his home in Norwood, Ohio, December 7, at the advanced age of seventy-eight years. He entered the employ of a machinist when nearly twenty-five years old, but made rapid progress in the business and established a small repair shop of his own in 1850 at Cincinnati. The firm of Lane & Bodley was formed in 1852, and the business has been carried on under the firm name ever since. Mr. Lane was greatly interested in educational matters and took an active part in the founding of the Ohio Mechanics' Institute and Industrial Expositions.

Charles Potter, the inventor of the Potter printing press and president of the company manufacturing his presses, died in Plainfield, N. J., December 2, aged seventy-five years. He first engaged in the manufacture of printing presses in 1854, being associated with George H. Babcock. The venture not proving successful, the firm was dissolved and Mr. Potter began building cylinder presses in Westerly, R. I., in 1856. The firm of C. Potter, Jr., & Co. was established at Norwich, Conn., in 1865, and a new factory was built at Plainfield, N. J., in 1879.

William A. Durfee, a prominent mechanical engineer and inventor, died November 9 at the age of sixty-six years. Mr. Durfee was widely known as a writer on scientific subjects, and was a contributor to many engineering publications.

William H. Warren, the inventor of the celebrated Warren radial drill, died at his home on December 5th, aged 61 years. Mr. Warren had been engaged in the manufacture of machinery at Worcester, Mass., for many years.

Mr. John A. White, who was recently found dead in his office from gas asphyxiation, was one of the most prominent business men of Dover, N. H. He was a director of the John A. White Company, manufacturers of wood working machinery, Dover, N. H. This business was first started in Concord, N. H., by B. F. Dunklee in 1864. In 1873 it passed into the hands of Mr. Allen, who four years later sold out his interests to the present company. In 1891 the business was moved to Dover, and has since been conducted under the name of the John A. White Company. Mr. White, at the time of his death, was 61 years old.